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ERRATA—Page 214, first line, for Oodontophlogistus, read Odontophlogistus.
Page 127, third line in title, for Francis Island, read St. Francis Island.

INDEX TO THE TRANSACTIONS.

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Transactions

of

The Royal Society of South Australia (Incorporated)

VOL. XLVII.

ON AUSTRALIAN STAPHYLINIDAE (COLEOPTERA).

By ARTHUR M. LEA, F.E.S., Museum Entomologist.

[Read November 9, 1922.]

The family Staphylinidae, in actual numbers, is probably, in Australia, second only to the Curculionidae (if not actually in excess of it), but has been more neglected than any other of the large ones. Thus in Masters' Catalogue only 278 species, out of a total of 7,201, are recorded. In Sharp's Catalogue of the British Coleoptera, of a total of 3,193 species, 760 are Staphylinidae, these being in excess of the Curculionidae. Even now less than 1,000 species are known from Australia, a number certainly far short of that which occurs in Queensland alone.

My present purpose is not to revise the family, but to give a list of all the species previously recorded from Australia, with their distribution, notes on various species, and descriptions of new ones.

Masters' Catalogue of Australian Coleoptera was published when comparatively few species of the family were recorded from Australia, and many of those there noted have been generically transferred. In Junk's Coleopterorum Catalogus, Bernhauer and Schubert are now dealing with the Staphylinidae of the world, and to save space it was considered necessary only to refer to the pages of that Catalogue in which our genera are recorded. Our main geographical districts are recorded by initials as follows:—Q. (Queensland), N.S.W. (New South Wales), V. (Victoria), Tas. (Tasmania), S.A. (South Australia), W.A. (Western Australia), N.W.A. (North-western Australia), N.T. (Northern Territory), and C.A. (Central Australia). Synonymy of introduced species has usually been omitted.

No family of beetles may be more readily identified; the long abdomen, usually with seven conspicuous segments, short elytra, at most covering the base of the abdomen, and general appearance being at once distinctive. Most of the species are small and obscurely coloured and so seldom have an attractive appearance, even when properly "set." To see the abdomen clearly specimens should be mounted, when fresh, with all the segments fully exposed; this was seldom done with the specimens sent to me, and in general is neglected; the result is that the segments become more or less telescoped, and no dependence is to be placed upon their apparent size; the apparent shapes of the under parts also vary in appearance with the positions of the legs. It is often essential to examine the palpi, necessitating their dissection for examination under the microscope. The

mandibles are usually clenched, but are easily relaxed in water, although, when thin, they are often broken on being forced open. A greater variation in the apparent numbers of tarsal joints occurs in the family than in any other, and owing to the density of their clothing it is frequently difficult to be sure of their numbers. The male usually has one or more segments of the abdomen triangularly notched on the under-surface, and its head is often larger than that of the female.

Macleay[1] was the first to name any considerable number of Australian species, when dealing with the insects of Gayndah; many of his types were re-described by Olliff.

Fauvel[2] was the first to revise the Australian species as a whole, but included with them those of Polynesia. He also had a paper[3] dealing with the Staphylinidae of Molucca and New Guinea, in which many of our species were described, although not then known from Australia. Many of his types passed to the British Museum from Sharp's collection.

Olliff[4] commenced a revision of the family in 1886, and three parts were published; most of his types are in the Australian and Macleay Museums, but a few passed from the Simson collection into the South Australian Museum.

Blackburn often dealt with species of the family in his papers in the Transactions of the Royal Society of South Australia, and the Proceedings of the Linnean Society of New South Wales. Some of his specimens were identified by Sharp. His types are mostly in the British Museum, but a few are in the South Australian and National Museums.

Bernhauer[5] dealt with the Staphylinidae taken in Western Australia by Michaelsen and Hartmeyer; and by Mjoberg[6] in Queensland and other parts of Australia.

I have also previously dealt with members of the family in the Transactions of the Royal Society of South Australia, Proceedings of the Linnean Society of New South Wales, Proceedings of the Royal Society of Victoria, and Records of the South Australian Museum.

In addition to the works previously quoted I have, amongst others, consulted the following authors, whose works will be found useful to students of the family:—

Cameron. New Species of Staphylinidae from Singapore; in Transactions of the Entomological Society of London, 1920.

Erichson. Genera et Species Staphylinorum.

Fenyes. Aleocharinae, in Wytsman's Genera Insectorum, fasc. 173.

Lacordaire. Genera des Coleopteres, ii.

Leconte and Horn. Classification of the Coleoptera of North America.

Kraatz. Insecten Deutschlands, ii.

Sharp. Biologia Centrali Americana, i. (2).

Although Cameron expressly states that "The characters in the tables do not necessarily apply to the species not found in Singapore," his tables will be found very useful to anyone dealing with species from tropical parts of Australia.

Some of Macleay's descriptions are certainly poor, but his types are fortunately available for examination in the Australian Museum. Fauvel, although he sharply criticised Macleay's work, often published no better descriptions himself, as they are frequently little more than comparisons with ex-Australian species,

(1) Macleay, Trans. Ent. Soc. N.S. Wales, ii.
(2) Fauvel, Ann. Mus. Civ. Gen., 1877 and 1878.
(3) Fauvel, *L.c.*, 1878.
(4) Olliff, Proc. Linn. Soc. N.S. Wales, 1886 and 1887.
(5) Bernhauer, Die Fauna Sudwest Australiens, Jena, 1908.
(6) Bernhauer, Arkiv. For Zoologi, 1916 and 1920.

colour often not being mentioned. Some years ago, realizing this difficulty, and also that many species were liable to be introduced to Australia in ships, I commenced the formation of an European collection of the family; these specimens, together with those owned by the late Rev. T. Blackburn, by the late Mr. Aug. Simson, and some from other sources, are now in the South Australian Museum, and have proved of great assistance.

I have examined all of the Australian types of Macleay and Olliff, and many of Blackburn's; also many cotypes of Blackburn and Fauvel, and of species identified by them. Some of the specimens collected in Australia by Mjoberg and identified or named by Bernhauer, were received from the Stockholm Museum; some years ago I also saw a few specimens belonging to the Western Australian Museum, taken by Michaelsen and Hartmeyer, and identified by Bernhauer. So that with few exceptions authentic specimens of most of the previously named species have been examined. To Mr. G. J. Arrow I am particularly indebted for the examination of some of Fauvel's cotypes, belonging to the British Museum, these enabling synonymy to be confidently noted that in several cases might otherwise have been dubious, or overlooked. The examination of long series of many species has also enabled notes on variation and synonymy to be made, and to extend the known ranges of many species. Specimens were received from the British, Queensland, Australian, Macleay, and National Museums; from Drs. M. Cameron and E. W. Ferguson, and from Messrs. E. Allen, H. J. Carter, J. Clark, H. W. Davey, A. H. Elston, E. Fischer, J. C. Goudie, H. H. D. Griffith, R. F. Kemp, C. Oke, and F. E. Wilson.

The numbers of species and specimens of the family that may be obtained by sieving a few square yards of fallen leaves in gulleys and other damp places is amazing. Mosses and tussocks often shelter them in abundance, and some curious wingless, slow-moving species have only been taken from mosses. More species of the family are to be taken from nests of ants, than of all other kinds of beetles, and some of the inquilines have very curious habits, as well as being structurally abnormal. Others are to be taken under bark, under seaweeds, and other beach *debris*. During floods they may often be seen in countless thousands. At dusk on warm days they may often be seen flying in great numbers, their bodies held at about 45 degs. from the ground-line, and their elytra held parallel with it. Curious slow-moving species are to be taken in brown cores in pipes of trees. Considerable numbers of thin and minute, subterranean, blind species have been taken in Europe by very careful special methods, but in Australia the only blind species known, *Typhlobledius cylindricus*, and *Tripectenopus caecus*, are fairly large, although of each only one specimen is known. Of one curious species, *Cryptommatus jansoni*, several specimens have been taken in Tasmania, from the anal region of bush rats. A few species frequent flowers, and in the tropics many are arboreal. Many are attracted to lights.

In general the species may be regarded as scavengers, feeding on decaying animal and vegetable substances. In parts of the world where large animals are abundant, dung-frequenting species are far more numerous than in Australia. Many have been introduced all over the world, in commerce; they are readily transported in hay and straw; dung-frequenting species frequently travel in ships with horses, cattle, and other animals.

Subfamily PAEDERIDES.

This subfamily, although not the largest, contains perhaps a greater number of interesting species than any other of the family. A few species of the typical genus *Paederus* are abundant and widely distributed, but most of them are rare.

PINOPHILUS, Grav., Cat., p. 1919.

In all the specimens of this genus examined by me the mandibles were clenched, so that it was impossible to decide as to whether they were dentate or not, and this appears to have been the case with (at least) most of the Australian specimens that have been made into types. On placing the specimens in water for about an hour, however, they may be softened so as to allow the mandibles to be opened, and it will then be seen that by them the Australian species of the genus may be divided into four groups, as follows:—

1. Mandibles unarmed.

LATEBRICOLA, Blackb. MAJOR, Lea. PUNCTIFRONS, Lea. RUFITARSIS, Fvl. TRAPEZUS, Fvl.

2. Each mandible with a small, acute, subbasal tooth.

APTERUS, Lea. AUSTRALIS, Har. (on this species the subbasal tooth is so small that it could be easily overlooked). MASTERSI, Macl.

3. Each mandible with an acute submedian tooth.

MACLEAYI, Duv. RUBRIPENNIS, Fvl.

4. Each mandible with an acutely bicuspidate submedian tooth.

AENEIVENTRIS, Fvl. QUADRATICOLLIS, Lea. SEMIOPACUS, Lea.

Of the species not noted above:—

CURTICORNIS, Fvl. Is probably allied to *P. rubripennis,* and so may belong to the third group; its mandibles were not even mentioned in the original description.

GRANDICEPS, Macl. Is allied to *P. trapesus,* and probably has unarmed mandibles.

MARGINELLUS, Fvl. Some specimens commented upon as probably belonging to this species have curious mandibles, figured for comparsion with those of the numbered groups.

Despite the variation in the mandibles the Australian species have a strong general resemblance, and all appear to be congeneric. Sharp, however,[7] says: "The genus *Aracocerus,* Nordm,[8] is ascribed to *Pinophilus* as a synonym by Erichson and others, but this is a mistake, as *Aracocerus* is well distinguished by the edentate mandibles." So that apparently he would refer all the species of the first group to *Aracocerus.* Erichson[9] says, "*Mandibulae . . . medio dente valido truncato,*" a character which, if insisted upon, would exclude all the Australian species here dealt with, with the possible exception of *P. marginellus;* as the only specimens I have seen to which it would apply are some of the third group from which the tips of the bicuspidate tooth have been broken. Lacordaire,[10] who also included *Araeocerus* as a synonym, says, "*Mandibules . . . fortement unidentees en dedans,*" which would exclude all those of the first and fourth groups. Fauvel, without comment, referred species to the first, third, and fourth groups.

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[7] Sharp, Biol. Cent. Amer., I. (Part 2), p. 620.

[8] *Araecerus* of the Anthribidae was used by Schonherr in 1826, and altered by Gemminger and Harold, in 1872, to *Araeocerus,* despite the fact that Nordmann had, in 1837, used the latter form for a genus of Staphylinidae.

[9] Erichson, Gen. et Spec. Staph., p. 669.

[10] Lacordaire, Gen. des Coleopt., ii., p. 102.

AENEIVENTRIS, Fvl. Q., N.S.W., V., S.A., N.W.A., N.T.
AUSTRALIS, Gemm. et Har. N.S.W.
opacus, Redt.
CURTICORNIS, Fvl. Q.
GRANDICEPS, Macl. Q., V.
LATEBRICOLA, Blackb. S.A., V., C.A.
MACLEAYI, Duv. Q., N.S.W., V., N.T.
brevis, Macl., n. pr.
MARGINELLUS, Fvl. Q., V., S.A., N.W.A.
MASTERSI, Macl. Q., N.W.A.
QUADRATICOLLIS, Lea. N.S.W., N.W.A., N.T.
RUBRIPENNIS, Fvl. Q., N.S.W., N.W.A.
jejunus, Lea.
RUFITARSIS, Fvl. V., Tas., S.A.
TRAPEZUS, Fvl. N.S.W., V., S.A., C.A.

PINOPHILUS AENEIVENTRIS, Fvl.

A specimen from Oenpelli (Northern Territory) in the National Museum appears to belong to this species, but has the legs much darker than on typical specimens (almost black, except that the tarsi are paler); another specimen, probably immature, from the same locality is entirely of a dingy (but not uniform) castaneous-brown; an almost identical specimen, but even paler, is in Mr. Carter's collection, from Cooktown. A specimen from North-western Australia appears to belong to the species, but differs from several, from Victoria and South Australia, in having the punctures of the prothorax and elytra denser and the legs darker (although not black). On its right mandible the median tooth is acutely bicuspidate, on the left one less conspicuously so; and they similarly vary on all those whose mandibles I have forced out for examination.

PINOPHILUS MARGINELLUS, Fvl. Fig. 3.

Two specimens from Queensland (Cairns and Brisbane) agree so well in colour and in most details with the description (and characters given in the table) of this species that I am averse from regarding them as new; they differ from the description, however, in having the prothorax transverse (about one-fifth wider than long), and with the apical joint of the antennae subtriangularly pointed. The type was from Melbourne, but so many species of the genus are widely distributed that the great distances apart from which the specimens were taken should hardly be considered. Each mandible near the middle is dilated, and then evenly continued to the basal enlargement, so that from some directions it appears dentate.

PINOPHILUS TRAPEZUS, Fvl.

A specimen from Yackandandah (Victoria), in Mr. Davey's collection, differs from typical ones of this species in being of a dingy castaneous-brown, except that the abdomen is darker. Of the mandibles of this species Fauvel only mentioned their colour. On two specimens identified by Blackburn as belonging to the species the mandibles are long, curved, and simple.

PINOPHILUS RUBRIPENNIS, Fvl. Fig. 4.

P. jejunus, Lea.

This species varies in the colour of the abdomen from entirely dull reddish-brown or black to black, with the two apical segments and the tips of all the others reddish, the head varies from a dingy-brown to black, and the legs, from almost the same shade of colour as the elytra, to pale flavous. The type of *P. rubripennis* was from New South Wales, of *P. jejunus* from North-western Australia, but the species also occurs in Queensland.

PINOPHILUS MACLEAYI, Duv.

A specimen from Broadmeadows (Victoria) in Mr. Oke's collection, has the head and prothorax of a rather dark castaneous, the elytra darker and the abdomen almost black, except that its tip and sides are obscurely paler.

PINOPHILUS LATEBRICOLA, Blackb.

Three specimens from Coburg (Victoria) possibly belong to this species, but they differ from typical ones in having the jaws about one-fourth longer and less suddenly departing from the general curvature at the inner base. With the jaws clenched the differences could not be noted, but when open they are at once evident; they are not sexual, as a male of each form has been compared.

Pinophilus major, n. sp. Fig. 5.

♂. Black; mouth parts, antennae, palpi, and tarsi reddish. Rather densely clothed with short, subdepressed, ashen pubescence; a few hairs on head and numerous ones about apex of abdomen.

Head strongly transverse; with crowded and not very large but sharply-defined punctures, becoming sparser, but still fairly numerous in front of a semicircular, shining line connecting the antennary tubercles. Mandibles long, thin, curved, and simple. Antennae long and very thin. Prothorax scarcely as long as the greatest width, hind angles strongly rounded off, front ones almost square, apex truncated except for a slight incurvature towards each side; with crowded punctures, much as on base of head; median line represented by a feeble remnant near base. Elytra very little longer than prothorax and scarcely as wide as its apex, very little longer than wide; punctures somewhat denser and more angular than on prothorax, and in places partly transversely confluent. Abdomen with crowded, suboblong punctures at base of most of the segments, becoming smaller and less crowded posteriorly, apex of apparent sixth segment triangularly notched on under-surface. Front femora very stout and obtusely dentate, four basal joints of front tarsi forming a very wide pad. Length, 20-25 mm.

Hab.—New South Wales: Darling River, in flood *debris* (R. Helms); North-western Australia (Dr. A. M. Morgan).

The largest species as yet recorded from Australia, from *P. australis,* the next in size, the present species differs in having the mandibles quite simple, the legs darker, elytra longer, and body winged. On close examination a few minute punctures may be seen scattered amongst the larger ones on the front part of the head. On the type two basal joints of the antennae are partly black, the front tarsi are much paler than the others, the knees and tip of abdomen are obscurely reddish. The specimen from North-western Australia has the front legs entirely reddish, and the others with only part of the femora infuscated.

Pinophilus punctifrons, n. sp.

♂. Black; antennae (most of the joints partly infuscated), palpi and tarsi more or less reddish. Rather densely clothed with dark pubescence, sparser on head (parts of which are glabrous) than elsewhere; in addition with rather long hairs scattered about, and becoming numerous on apex of abdomen.

Head strongly transverse, hind angles moderately rounded off; punctures of moderate size, sharply defined and irregularly distributed. Mandibles long, thin, curved, and simple. Antennae long and very thin, all the joints much longer than wide. Prothorax about as long as the apical width, apex (except for a feeble incurvature towards each side) truncate, sides gently rounded but hind angles strongly rounded; punctures much as on base of head; median line distinct only near base. Elytra about once and one-third the length of prothorax and very little wider than its apex; punctures rather more crowded, but scarcely larger. Abdomen with crowded angular, more or less confluent punctures at the base of most segments, becoming smaller posteriorly on each, apparent sixth segment triangularly notched at apex on under-surface. Legs not very long; front femora very stout, with a ridge ending as an obtuse tooth; front tarsi with four basal joints dilated to form a wide pad. Length, 19 mm.

♀. Differs in having the abdomen not notched and its tip obscurely reddish.
Hab.—New South Wales: Hay (A. M. Lea); Victoria: Murtoa.

A large, shining, black species, with simple mandibles, readily distinguished from all others known to me (except *P. marginellus*, which has tips of the elytra red, and very different mandbles) by an even row of four large setiferous punctures across the front of the head; between these and the basal third (where they are crowded) the punctures are very sparse and subseriately arranged; on close examination minute punctures may be seen scattered about.

Pinophilus apterus, n. sp. Fig. 6.

♀. Pale castaneous, abdomen darker, antennae, palpi, and legs paler. Rather densely clothed with dark pubescence, sparser on head than elsewhere, and with long hairs scattered about, becoming numerous on apex of abdomen.

Head strongly transverse, hind angles strongly rounded; with fairly large and sharply-defined punctures, crowded about base, forming an irregular double semicircle between antennary tubercles, and an irregular row in front; with minute ones scattered about. Mandibles long, thin, curved, and with a small acute tooth near base. Antennae rather long and thin, all of the joints longer than wide, and evenly decreasing in length after the third. Prothorax slightly transverse, hind angles strongly rounded, the front ones moderately so, sides gently rounded, apex considerably wider than base and just perceptibly wider than head; with crowded punctures, distinctly smaller than on head, the interspaces with very minute ones; median line very feeble, but traceable almost throughout. Elytra transversely oblong, narrower and much shorter than prothorax; punctures slightly larger and more crowded than on prothorax. Abdomen with crowded punctures on both surfaces. Front femora very stout, with a feeble, abruptly-terminated ridge; four basal joints of front tarsi forming a strongly-dilated pad. Length, 13 mm.
Hab.—New South Wales: Gosford (H. W. Cox). Unique.

An unusually robust, apterous species with transverse elytra. The jaws, when clenched, appear to be simple, but on relaxation they are seen to have a minute acute tooth near the basal swelling, much as on *P. mastersi*, which is a much narrower species, with very different abdomen. Its nearest ally appears to be *P. australis*, but the head has a shorter space between the eyes and neck, the tooth on each mandible is slightly more advanced and acute, the prothorax is distinctly transverse, and the punctures are slightly less dense. The type is almost certainly immature, but as it represents a very distinct species it was considered desirable to name it.

Pinophilus semiopacus, n. sp. Fig. 7.

♀. Black; antennae, palpi, and legs flavous, abdomen iridescent, its tip and the mandibles reddish; with rather dense black pubescence, and with numerous hairs scattered about.

Head strongly transverse, base obtusely bilobed; with crowded punctures of several sorts. Eyes unusually large. Mandibles long, acute, and each armed with a large, acutely bicuspidate median tooth. Antennae very thin, passing base of prothorax, all the joints longer than wide, but decreasing in length after the third. Prothorax about as long as apical width, hind angles strongly rounded, front ones almost square; with crowded punctures; median line feeble, but traceable almost throughout. Elytra slightly wider than prothorax and about once and one-third as long, sides gently rounded, the angles rather strongly so; with crowded punctures, slightly larger than on prothorax, and many transversely or obliquely confluent. Abdomen with punctures scarcely smaller but somewhat shallower than on elytra, more crowded and confluent

about the bases of the segments than elsewhere. Front femora very stout, with a thin and rather abruptly terminated ridge; front tibiae strongly dilated from base to beyond the middle, and then unevenly excavated on one side to apex; front tarsi with four basal joints inflated to form a very large pad. Length, 16-17 mm.

Hab.—Queensland: South Johnstone River (H. W. Brown), Cairns (E. Allen). Type, I. 12627.

The bicuspidate tooth on each mandible associates this species with *P. quadraticollis*, and *P. aeneiventris*, from which it differs in being much larger; from the former it also differs in having the prothorax not shagreened, although with unusually dense punctures, antennae longer, and elytra uniformly coloured; from the latter it differs also in the much more crowded and less uniform punctures; the latter has the abdomen more brightly iridescent. The head, from a semicircular space connecting the antennary tubercles, is shining in front, and opaque behind, the opacity due to the dense crowding of punctures, which (except near the shining part) cannot be individually distinguished; on the shining part there are numerous fairly large ones, very numerous small ones, and still more numerous minute ones irregularly intermingled. The punctures on the prothorax, although densely crowded, are seldom confluent, so that they are nearly all sharply defined, they are smaller than the large ones on the head. From certain oblique directions the elytra appear to be densely granulate. On both specimens the front femora and tibiae are, in parts, deeply infuscated. The front tarsal pad is unusually large, even for the genus, and its outer base is produced backwards to fit into a depression on the sides of the tibia; on *aeneiventris* it is somewhat smaller, but is otherwise similar. Where type numbers are given they are those of the South Australian Museum.

PROCIRRUS, Latr., Cat., p. 197.

The species here referred to this genus have the head rather small, with a long neck, the antennae thin, with all the joints longer than wide, apical joint of maxillary palpi long and acuminate, prothorax at least twice as long as wide, sides of abdomen practically immarginate, four basal joints of front tarsi dilated and subquadrate, basal joint of middle ones much longer than the rest combined, hind ones with basal joint twice as long as the rest combined, and the fourth joint short, bilobed, and with a membranous flap. I have seen but one ex-Australian species, but the characters given by Erichson,[11] Lacordaire,[12], and Fauvel[13] seem conclusive.

CASTELNAUI, Fvl. N.S.W., V., S.A. VICTORIAE, Fvl. N.S.W., V.

PROCIRRUS VICTORIAE, Fvl.

The description of this species is but little more than a comparison with the ex-Australian *P. lefevrei*, but, such as it is, it agrees with three specimens before me, from Sydney and Melbourne, except that they are somewhat smaller—10-10.5 mm.

Procirrus dolichoderes, n. sp. Fig. 1.

♂. Black; elytra brick-red, antennae, palpi, and tarsi of a more or less dingy red, but in parts deeply infuscated. Clothed with short, depressed, ashen pubescence.

Head moderately large, narrowed in front of eyes and rounded behind them, towards base greatly narrowed, and with a long thin neck; with dense and sharply-defined punctures of moderate size. Mandibles long and acute,

(11) Erichson, Gen. et. Spec. Staph., p. 685.

(12) Lacordaire, Gen. Col., ii., pp. 102, 105.

(13) Fauvel, Ann. Mus. Civ., Gen., 1878, p. 506.

about middle with a strong double tooth. Antennae thin, none of the joints transverse, first as long as second and third combined, eleventh almost as long as ninth and tenth combined. Prothorax about twice as long as wide, widest near apex, sides slightly incurved near base, front angles completely rounded off; with dense punctures much as on head, but becoming coarser near base. Elytra about the length of prothorax, but conspicuously wider, and slightly wider than head, angles rounded off; with dense and rather deep punctures, somewhat larger than on base of prothorax. Abdomen about half the total length, with crowded punctures; subapical segment feebly incurved at apex on under-surface, the apical one deeply notched. Legs long and thin, hind tibiae with a conspicuous projection near outer apex; front tarsi stout, four basal joints lopsided, fifth thin; middle and hind tarsi thin, the basal joint distinctly longer than the rest combined. Length, 10-11 mm.

Hab.—Victoria: Geelong and Portland (H. W. Davey).

Close to the species I have identified, with some doubts, as *P. victoriae*, but head narrower, antennae longer, and elytra entirely pale. At first glance the derm appears to be opaque, but this is entirely due to the short clothing. The neck, thin as it appears from above, appears much thinner from the sides; it has a thin ridge, and this may be traced as an impunctate line to half-way between the eyes. From above the abdomen appears to be immarginate, but on the sides feeble ridges may be seen towards the base of most of the segments. The punctures on the under-surface are much as on the elytra, except on the head, where they are more rugose, with the interspaces opaque or shagreened. The basal joint of the hind tarsi is almost twice as long as the rest combined.

Procirrus opacus, n. sp.

♂. Opaque piceous-brown, head and most of abdomen still darker. Basal half of antennae, maxillary palpi, mandibles and legs reddish, labial palpi, apical half of antennae and tarsi paler. Clothed with very short, depressed, ashen pubescence.

Head rather long, constricted in front of eyes, rounded behind them, and with a long and thin neck, a very thin ridge on basal half; with crowded and rather small but sharply-defined punctures. Mandibles long and acute, with a strong double tooth before the middle. Antennae long and thin, basal joint rather stout and almost as long as second and third combined, apical joint distinctly longer than tenth, median joints slightly shorter and thinner than the others. Prothorax fully twice as long as wide, sides widest in front, slightly incurved near base, front angles rounded off, a very narrow ridge on basal two-thirds; with crowded punctures, somewhat coarser than on head, especially at base. Elytra conspicuously wider than prothorax, and about the same length; with somewhat similar punctures. Abdomen long; with crowded punctures; a short feeble ridge on most of the segments on each side representing the margins, but the sixth with a narrow slit on each side; under-surface of subapical segment with an equilaterally triangular notch. Legs long and thin; hind tibiae with a projection near outer apex; front tarsi with four basal joints large and lopsided, hind tarsi very long, the basal joint more than twice as long as the others combined, middle tarsi shorter but somewhat similar to the hind ones. Length, 9-11 mm.

Hab.—North-western Australia: Derby (Dr. A. M. Morgan), Fortescue River (W. D. Dodd). Type, I. 12656.

In general close to *P. dolichoderes*, but the derm really opaque and not apparently so only; the elytra are of the same dingy colour as the prothorax, this is less rounded in front and the legs and antennae are paler. The punctures cause the prothorax to appear densely and finely granulate.

Procirrus antiquus, n. sp.

♂. Opaque-black; antennae, palpi, mandibles, and legs more or less reddish. Densely clothed with very short ashen pubescence. Length, 7.5 mm.

Hab.—North-western Australia: Derby (W. D. Dodd). Type (unique), I. 12657.

The dingy pubescence on the opaque derm give the whole insect a dingy, rusty appearance; the darker parts of the abdomen (except the tip) are entirely black, but the softer parts cause the tip of each segment to appear reddish. Structurally it is very close to the preceding species, but differs in being much smaller, black, the punctures on the head smaller and denser, and in consequence less sharply defined, the ridge on the prothorax shorter and less conspicuous, the notch on the abdomen much wider, and the slit on each side of the sixth segment very faint. From some directions the elytra and most of the prothorax appear multi-granulate.

In forcing out the mandibles they were unfortunately injured, but the parts that are visible are as on the preceding species.

Procirrus ferrugineus, n. sp.

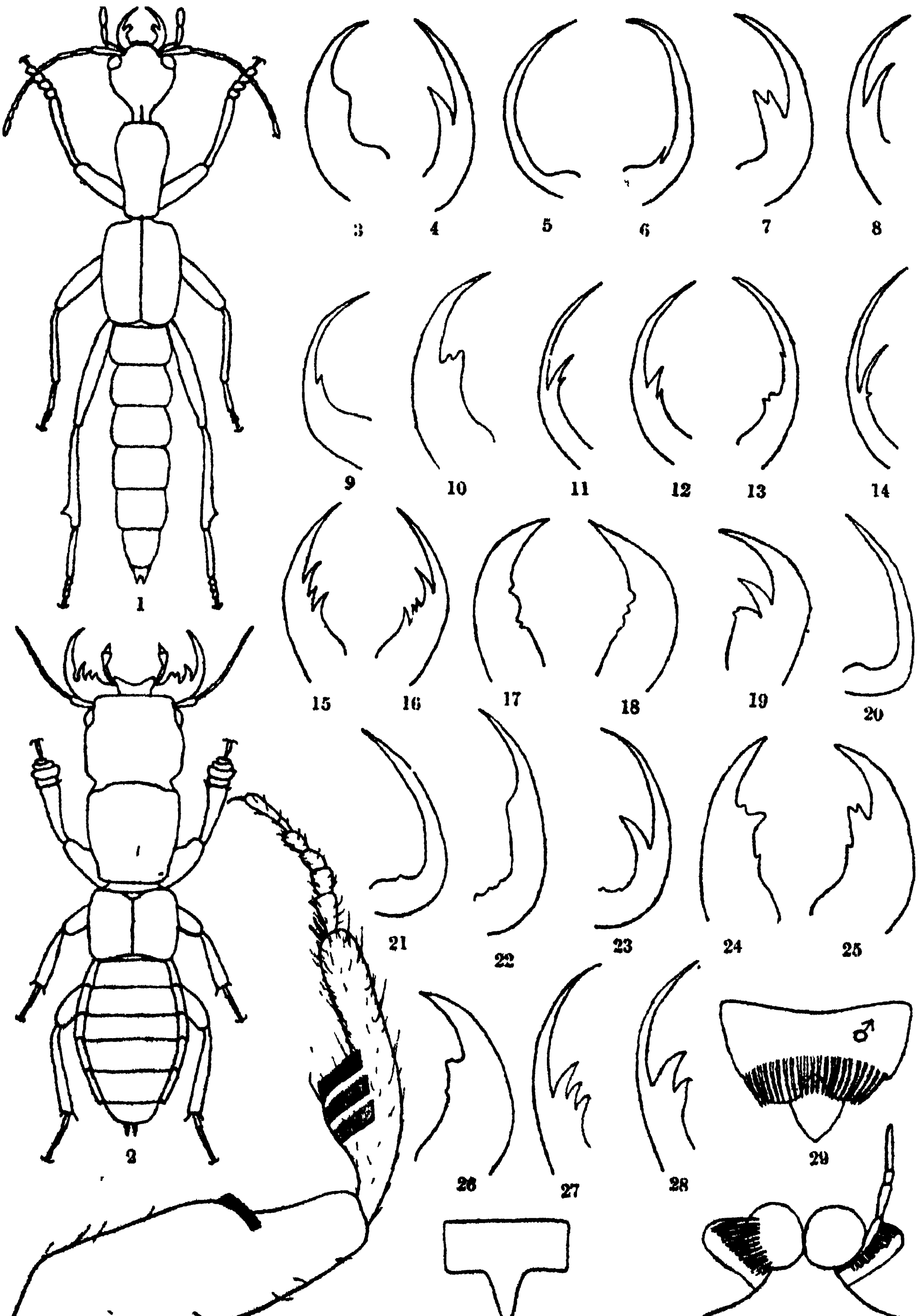
♀. Of a dingy rusty reddish-brown; mouth parts, antennae, palpi, elytra, and legs paler, head almost black. Densely clothed with short, ashen pubescence, becoming longer on tips of abdominal segments.

Head rather small, moderately convex, hind angles strongly rounded off, with a short narrow neck; with crowded and rather small punctures. Mandibles long and acute, a strong tooth near the middle. Antennae rather short, first joint as long as second and third combined, second almost as long as third and fourth combined, fifth to ninth as long as wide, or feebly transverse, tenth longer, eleventh still longer. Prothorax about twice as long as wide, widest at apex, which is about the width of head, sides feebly diminishing in width posteriorly, all angles gently rounded off, with a faint median ridge on basal half; punctures crowded and slightly larger than on head. Elytra about as long as prothorax, and somewhat wider, shoulders rounded, sides thence parallel to near apex; with rather coarse crowded punctures. Abdomen more than half total length; with dense asperate punctures, becoming crowded at the base of each segment; sides immarginate. Legs not very long; front tarsi with four basal joints strongly dilated; middle tarsi scarcely as long as the front ones, the basal joint as long as the rest combined; hind tarsi slightly longer than the middle ones, the basal joint considerably longer than the others combined; hind tibiae

EXPLANATION OF FIGURES.

Fig.
1. *Procirrus dolichoderes*, Lea.
2. *Macrodicax potens*, Lea.
3. *Pinophilus marginellus*, Fvl. Mandible.
4. „ *rubripennis*, Fvl. Mandible.
5. „ *major*, Lea. Mandible.
6. „ *apterus*, Lea. Mandible.
7. „ *semiopacus*, Lea, Mandible.
8. *Palaminus bivittipennis*, Lea. Mandible.
9. *Oedichirus cribricollis*, Lea. Mandible.
10. *Paederus wilsoni*, Lea. Mandible.
11. *Astenus noctivagus*, Lea, Mandible.
12. „ *mandibularis*, Lea. Mandible.
13. „ *mandibularis*, Lea. Mandible.
14. „ *ambulans*, Lea. Mandible.
15. *Medon lugubris*, Lea. Mandible.
16. „ *lugubris*, Lea. Mandible.
17. *Lathrobium orthodoxum*, Lea. Mandible.

Fig.
18. *Lathrobium orthodoxum*, Lea. Mandible.
19. „ *abdominale*, Lea. Mandible.
20. *Hyperomma globuliferum*, Lea. Mandible.
21. „ *cylindricum*, Lea. Mandible.
22. „ *labrale*, Lea. Mandible.
23. „ *bryophilum*, Lea. Mandible.
24. *Dolicaon alatus*, Lea. Mandible.
25. „ *alatus*, Lea. Mandible.
26. „ *alatus*, Lea. Mandible.
27. *Cryptobium hoplogastrum*, Lea. Mandible.
28. „ *bicuspidatum*, Lea. Mandible.
29. *Astenus pectinatus*, Fvl. Tip of abdomen.
30. *Domene pectinatrix*, Lea. Front leg.
31. *Hyperomma globuliferum*, Lea. Part of mouth.
32. *Cryptobium hoplogastrum*, Lea. Third segment of abdomen.



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slightly dilated from base to near apex, the outer side then notched to apex. Length, 7.5 mm.

Hab.—Victoria: Ararat (H. W. Davey). Unique.

Differs from all other species here referred to *Procirrus* in having the neck more suddenly defined from the head, although not longer, and the middle and hind tarsi with the basal joint shorter, although still of great comparative length. It is about the size of *P. castelnaui*, but is apparently a considerably paler insect; the description of that species, however, is but little more than a comparison with the ex-Australian *P. saulcyi*. The derm itself is somewhat shining, but owing to the clothing appears subopaque. Seen directly from above the black part of the head (excluding the neck) appears almost circular, but when viewed from behind it appears parallel-sided for some distance. The tooth on the left mandible (the only one visible on the type) is truncated at the apex, but may have been damaged in manipulation. From some directions both prothorax and elytra appear to be closely granulate. The largest and most sharply-defined punctures are on the metasternum and under-surface of abdomen.

There is a specimen of this species in the Australian Museum (K. 21538) from Singleton (New South Wales).

PALAMINUS, Er., Cat., p. 198.

In addition to the species here listed Blackburn[14] has recorded two others (*P. novaeguineae*, Fvl., and *P. vitiensis*, Fvl.) as Australian, but probably in error.

AUSTRALIAE, Fvl. Q., N.S.W., V., N.W.A., Lord Howe Island.
malandanus, Bernh., Arkiv for Zool., xiii. (No. 8), p. 8.
MACULATUS, Bernh., *l.c.*, p. 9. Q., N.S.W.

PALAMINUS AUSTRALIAE, Fvl.

Specimens of this species are before me from Queensland (Cairns, Mount Tambourine, and Goodna), New South Wales (Wollongong and Sydney), Victoria (Alps and Dividing Range), and Lord Howe Island. The abdomen is more castaneous than the rest of the upper-surface, the elytra are uniformly flavous, except that on some specimens parts adjacent to the suture are as dark as the abdomen; the size varies from 2.5 to 4.5 mm. The longitudinal elevation on the prothorax varies from a feeble subbasal tubercle to a moderately long carina. It appears probable that *malandanus* was named from small specimens of the species.

PALAMINUS MACULATUS, Bernh.

On the typical form of this species the elytra are dark with the suture, tips, and shoulders pale, but the dark parts vary in intensity, and on some specimens are reduced to a sutural blotch on the basal half (two such specimens were identified by Blackburn as *P. novaeguineae*).

Palaminus bivittipennis, n. sp. Fig. 8.

Castaneous, elytra black with castaneous markings, mouth parts, antennae, palpi, and legs castaneous. With fairly numerous golden setae, or hairs, longer and more numerous on abdomen than elsewhere.

Head strongly transverse; with rather numerous, large, sharply-defined punctures. Eyes large, occupying most of the sides between antennae and base. Antennae long and thin, none of the joints transverse. Prothorax distinctly transverse, basal angles strongly rounded, sides increasing in width to apex,

(14) Blackburn, Trans. Roy. Soc. S. Austr., 1895, p. 204.

which is truncate; punctures much as on head. Elytra much wider than prothorax and about twice as long, sides gently rounded; punctures slightly larger, denser, and more angular than on prothorax. Abdomen long, four segments and base of another with characteristic sculpture of the genus; anal styles very long and thin. Front femora stout, obtusely dentate; front tibiae rather short, strongly dilated to apex, four basal joints of front tarsi large and lopsided; other legs rather long and thin. Length, 5-6 mm.

Hab.—Northern Queensland (Blackburn's collection). Type, I. 12429.

Two specimens are paler than the others, with the abdomen not much darker than the prothorax, on the others the abdomen (except the tips of the segments) is almost black. The darker specimens have the four basal joints of the front tarsi larger and more conspicuously lopsided than on the others and are probably males; I have been unable to find any other characters that appear to be sexual. The dark parts of the elytra vary in intensity, but in general may be considered as forming a dark U on each elytron (from each shoulder a pale vitta extends about to the middle on two specimens, almost to the apex on the others; the tips are also narrowly pale). In the middle of the prothorax there is a slightly elevated subtubercular space that appears to be the remnant of a median carina. Of the four specimens before me two were identified with doubt, by Blackburn, as *P. vitiensis*, Fvl., but they do not agree with the description, as on one of them the head and prothorax are uniformly dark castaneous, and on the other uniformly pale castaneous (the specimens before Fauvel had the prothorax trivirgate), and there are other differences from the description.

OEDICHIRUS, Er., Cat., p. 201.

ANDERSONI, Blackb. S.A., W.A.
GENICULATUS, Lea V.
GRANDIS, Bernh. Arkiv. for Zool., xiii. (No. 8), p. 7. Q.
INTRICATUS, Fvl. Q., N.T.
PAEDEROIDES, Macl. Q., N.S.W.
RUBRICOLLIS, Fvl. N.S.W.
TERMINALIS, Lea. N.W.A., N.T.
TRICOLOR, Lea. Vic., Tas.

OEDICHIRUS GRANDIS, Bernh.

A specimen, from Mount Tambourine, agrees with the description of this species, except that it is smaller (5.5 mm.); but as several species vary considerably in length, apart from post-mortem contractions, the difference in size is probably of no importance.

Oedichirus cribricollis, n. sp. Fig. 9.

♀. Black; antennae, palpi, and legs flavous, mandibles, labrum, and coxae with a slight tinge of red. Clothed with straggling, ashen setae.

Head small and (between labrum and base) transverse; with numerous large punctures, sparser in middle than elsewhere. Eyes large, about one-fourth longer than basal joint of antennae. Mandibles long and acute, with a rather small acute tooth about middle. Antennae thin, first joint almost as long as second and third combined, third slightly longer than second and slightly shorter than fourth. Prothorax slightly longer than greatest width, which is near apex, strongly rounded in front, behind the greatest width strongly obliquely narrowed to base; with irregular rows of very large punctures. Elytra small, sides strongly rounded; with rather numerous, large, deep punctures. Abdomen more than half the total length, most of the segments on the upper-surface with large oblong punctures, close together at base, then with round ones not so close together, and smaller ones about tips; on under-surface the punctures are somewhat similar but more numerous; anal styles long and acute. Legs rather long and thin, hind tibiae subtriangularly dilated and notched near outer apex. Length, 10 mm.

Hab.—Queensland: Cairns (A. M. Lea). Type (unique), I. 12615.

In general appearance like a large specimen of *O. grandis* (the only other Australian species having the prothorax black), but with longer and thinner legs, knees very little darker than the adjacent parts, instead of conspicuously black, and elytra of different shape; on *grandis* they are distinctly wider than long, with the sides almost evenly rounded, although narrower at base, on the present species they are scarcely wider than long, and (with rounded outlines) increase in width from base almost to apex. All the punctures are large and sharply defined, but those on the prothorax are largest of all.

Oedichirus cribriventer, n. sp.

♂. Blackish; mouth parts, antennae, palpi, prothorax, and legs more or less flavous. With long, straggling, ashen hairs.

Head (excluding neck) transverse, with rather large and deep punctures. Mandibles long and acute, each with a rather small acute tooth about the middle. Antennae thin, none of the joints transverse. Prothorax scarcely as long as the greatest width (almost at apex), sides strongly decreasing in width to base, with large and irregular punctures, crowded in places, but leaving a rather narrow and irregular median line. Elytra small, sides rather strongly rounded, apex much wider than base; with large and rather dense punctures. Abdomen more than half the total length; with large and dense punctures, becoming oblong at the base of each segment on the upper-surface, and rather less so on under-surface; subapical segment with a shallow depression on under-surface, its tip with a small and wide triangular notch. Legs rather long and thin, hind tibiae subtriangularly dilated and notched near outer apex. Length, 7.5 mm.

Hab.—Queensland: Gladstone (A. M. Lea). Type (unique), I. 12616.

Fairly close to *O. geniculatus*, but head black, legs entirely pale, elytra not entirely pale and with rather more numerous punctures; *O. rubricollis* has less irregular punctures on prothorax, legs partly and elytra entirely dark, etc.; *O. tricolor* has red head and prothorax, etc.; structurally it is close to *O. grandis*, but prothorax, elytra, and legs are very differently coloured and the punctures are somewhat different. At first glance the elytra appear to be as dark as the abdomen, but on close examination the base, suture, and tips are seen to be obscurely reddish.

PAEDERUS, Fabr., Cat., p. 203.

ADELAIDAE, Blackb. S.A.
ANGULICOLLIS, Macl.[15] Q., N.S.W., V., Tas., S.A.
tenuicornis, Fvl.
AUSTRALIS, Guer. Q., N.S.W., V., Tas., S.A., N.W.A., N.T.
CRUENTICOLLIS, Germ. Q., N.S.W., V., Tas., S.A., C.A.
cingulatus, Macl.
FUSCIPES, Curt. Australia. Introduced.
KOEBELEI, Blackb. Q., N.T.
MEYRICKI, Blackb.* W.A.
antipodum, Bernh. and Schub.
erichsoni, Bernh., n. pr.
SIMSONI, Blackb. Tas., King Island.
SJOESTEDTI, Bernh. (*Pseudopaederus*), Arkiv for Zool., xiii. (No. 8), p. 9. Q.
SPARSUS, Fvl. N.S.W., S.A.
TWEEDENSIS, Blackb. Q., N.S.W., N.T.

PAEDERUS TWEEDENSIS, Blackb.

Of this species I wrote to Mr. G. J. Arrow: "Specimens in my collection seem very close to the British and European *P. fuscipes*, Curt., differing only slightly in colour of legs. I would be glad if you would compare the type with normal specimens of *fuscipes* (which has been recorded by Bernhauer as

[15] Incorrectly referred to as *angulatus* in Proc. Linn. Soc. N.S. Wales, 1904, p. 63.

occurring in Australia)." In reply he wrote: "I can see no difference of any importance."

PAEDERUS MEYRICKI, Blackb.

P. erichsoni, Bernh., n. pr.

P. antipodum, Bernh. and Schub.

The description of *P. erichsoni* agrees well with specimens of *P. meyricki*, and a cotype from Bernhauer in the Western Australian Museum also agreed with them. As *erichsoni* was previously used in *Paederus*, in the catalogue by Bernhauer and Schubert the name was changed to *antipodum*.

Paederus apteromelas, n. sp.

Black; elytra dark metallic-blue or green. Clothed with black pubescence, interspersed with erect black hairs.

Head moderately long; with conspicuous irregular punctures. Eyes prominent. Antennae moderately long and thin, third joint slightly longer than first, distinctly longer than fourth, and about twice the length of second, eleventh pointed and slightly longer than tenth. Prothorax slightly longer than its greatest width, which is near apex, front angles strongly rounded off, base truncate; punctures somewhat as on head. Elytra narrow at base, dilated to apex, where the width is slightly more than head across eyes; with crowded and rather large round punctures. Abdomen widest in middle; punctures rather dense but partially concealed. Legs rather long and thin. Length, 6.5-7.5 mm.

Hab.—Western Australia: Swan River (J. Clark). Type, I. 12041.

An apterous species, structurally close to *P. meyricki*, but readily distinguished from that, and from all other named Australian species, by its black prothorax. Most of the seven specimens sent by Mr. Clark have parts of the under-surface of the basal joints of antennae obscurely reddish, and two also have parts of the prosternum obscurely reddish.

Paederus stenopterus, n. sp.

♂. Black; mouth parts, basal joints of palpi, antennae (four or five median joints deeply infuscated), prothorax, four basal segments of abdomen, coxae, and base of femora more or less reddish or flavous, rest of legs moderately or deeply infuscated. Upper-surface with straggling black hairs, but very sparse on prothorax; elytra and abdomen with sparse inconspicuous pubescence.

Head fairly large; with large irregularly-distributed punctures, almost absent from a median space from between eyes to clypeus. Antennae rather long, none of the joints transverse, third twice the length of second. Prothorax strongly convex, strongly rounded in front, where the greatest width is almost twice the width of base; with a few scattered punctures. Elytra slightly longer than prothorax, but considerably narrower than its greatest width, strongly narrowed at base; with large and somewhat crowded punctures. Abdomen slightly dilated posteriorly, sixth segment largest of all; with fairly large and dense punctures near base of segments; under-surface of subapical segment deeply notched. Legs long and thin. Length, 6.5 mm.

Hab.—Northern Queensland (Blackburn's collection). Type, I. 12613.

An apterous species, with antennae coloured much as in the winged *P. koebelei*; of the other apterous species it differs in its partly pale abdomen, legs, and antennae from *P. meyricki*, *P. simsoni*, and *P. apteromelas*; *P. sparsus* is a considerably larger species, with entirely dark abdomen, etc. A female (South Johnstone River, H. W. Brown) that appears to belong to the species, differs from the type in being larger (7 mm.), four basal segments of abdomen

less conspicuously paler than the others (although not black), the subapical segment not notched, and the elytra of a brighter blue.

Paederus wilsoni, n. sp. Fig. 10.

♂. Black; elytra blue or purplish-blue, mandibles and prothorax red, antennae (four or five median joints infuscated), palpi, and most of the legs flavous. Upper-surface with long, straggling, black hairs.

Head moderately large; with fairly large but sparse punctures. Mandibles with an acutely bicuspidate tooth about middle. Antennae long, none of the joints transverse, first and third of equal length, and each about twice the length of second. Prothorax large, strongly convex, sides strongly rounded and at widest slightly wider than head; with a few scattered punctures. Elytra small, slightly shorter than prothorax and distinctly narrower; with large irregularly-distributed punctures. Abdomen large; with a few distinct punctures; under-surface of subapical segment with a rather narrow parallel-sided notch almost to base. Legs rather long and thin, front femora stout. Length, 7-9 mm.

♀. Differs in having abdomen slightly wider posteriorly, subapical segment not notched, and legs and antennae somewhat shorter.

Hab.—Queensland: Blackall Range in October (F. E. Wilson), Mapleton in November (H. Hacker). Type, I. 12859.

On several males the tibiae and tarsi are entirely pale, but not of a clear flavous, as are the bases of the femora; but on most of them the tibiae, at least, are infuscated about the base. The elytral punctures are rather large and sparse, and so impressed that the space immediately behind most of them appears to be granulate. It is an apterous species, nearer to *P. sparsus* than any other wingless one, but the elytra are subgranulate, abdomen with more conspicuous margins, and antennae with only the middle dark; the antennae are coloured as on some specimens of the winged *P. koebelei.* From the preceding species it differs in having the elytra smaller, abdomen entirely polished black, and maxillary palpi entirely pale.

DIBELONETES, Sahlb., Cat., p. 212.

Sharp[14] gives particulars as to how this genus may be distinguished from *Sunius* (equal *Astenus),* but it is doubtful if the Australian species now standing in it can be maintained as distinct from that genus.

ANTIPODUM, Bernh., Arkiv for Zool., xiii. (No. 8), p. 11. Q.

BREVICOLLIS, Lea *(Sunius).* Q., N.S.W.

queenslandicus, Bernh., *l.c.,* p. 11.

MJOEBERGI, Bernh., *l.c.,* p. 10. Q., S.A.

PALAEOTROPICUS, Bernh. Q., N.T., Melville Island (? Introduced).

DIBELONETES BREVICOLLIS, Lea.

D. queenslandicus, Bernh.

A very variable species, occurring from Cairns in Queensland, to Dalmorton in New South Wales.

Form 1. Pale reddish-flavous; elytra, antennae, palpi, and legs still paler.

Form 2. Darker than preceding form; head with one, prothorax with two vague infuscations; elytra with more or less numerous infuscated spots, sometimes sharply defined but not conjoined; upper-surface of abdomen infuscated on each segment near margin. The majority of specimens belong to this form; on most of them the outer apical angles of the elytra, and a spot on each side of the suture, appear conspicuously flavous from some directions,

(14) Sharp, Biol. Centr. Amer., i. (Part 2), 1886, p. 601.

so that the elytra appear to be of three colours: a rather dingy flavous-red or ferruginous, piceous, and black or brown. The type female is of this form.

Form 3. The typical form of both *brevicollis* and *queenslandicus*, but a rather rare one.

There are many other forms before me, represented by but one or two specimens, but they may be all recognized by the comparatively short prothorax, and small subgranular elevations on elytra.

DIBELONETES MJOEBERGI, Bernh.

A somewhat variable species. The W on the elytra is usually sharply defined, but on three specimens is so faint as to be scarcely traceable; the infuscation of the sides of the prothorax is occasionally pronounced, but is usually feeble, or altogether absent. I took fifteen specimens in the Cairns district, and one near Adelaide.

DIBELONETES PALAEOTROPICUS, Bernh.

I have not seen the description of this species,[17] but received from the Stockholm Museum two specimens taken by Mjoberg at Malanda and identified by Bernhauer. The species is a variable one, but may be recognized amongst the allies of *Astenus* by its greatly flattened and long head and prothorax, the head with a median line (infuscated or black), and the prothorax with a median line and a marginal one on each side (also infuscated or black). The elytra and abdomen have markings which vary in number and intensity. On two specimens the markings on the whole of the upper-surface are, however, very faint. Specimens under examination are from Cairns, Kuranda, and Melville Island.

ASTENUS, Steph., Cat., p. 213.

(*Sunius*, Er., a synonym, and *Astenognathus*, Reitt., a subgenus.)

APICIFLAVUS, Lea (*Stenus*). N.S.W.
AUSTRALICUS, Bernh. W.A.
CYLINDRICUS, Macl. (*Stenus*). Q., N.S.W., V., W.A.
var. *australasiae*, Fvl.
FAVOSUS, Lea (*Stenus*). Q.
GUTTULUS, Fvl. (*Stenus*). Q., N.S.W., V., Tas., S.A., W.A., Lord Howe and Norfolk Islands.
HACKERI, Lea (*Stenus*). Q.
INDICUS, Kr. (Subg. *Astenognathus*). Q., N.S.W., V., Tas., S.A., W.A. (also Europe, Africa, and Asia).
aequalis, Blackb. (*Sunius*).
oculatus, Sharp (*Sunius*).
pallidulus, Woll.
parviceps, Ragusa.
PECTINATUS, Fvl. (*Sunius*). N.S.W.
ROTUNDICOLLIS, Macl. (*Scopaeus*), Cat., p. 251. Q.
SIMSONI, Lea (*Sunius*). Tas.
TRILINEATUS, Lea (*Sunius*). N.S.W.

ASTENUS AUSTRALICUS, Bernh.

Mr. J. Clark took two specimens of this species on the Swan River, from a nest of *Ectatomma metallicum*; they measure 3.5 and 3.75 mm.

ASTENUS GUTTULUS, Fvl.

Two specimens from Cairns, and one from Darwin, possibly belong to this species, but they differ from typical ones in being somewhat thinner (the prothorax is distinctly, but slightly longer) and the spot on each elytron more elongate, and extending from just before the middle to about one-sixth from

[17] It is not mentioned in the Catalogue, but is recorded in Arkiv for Zool., xiii. (No. 8), p. 11.

apex, instead of rounded and submedian; on all three the head is no darker than the prothorax, the subapical segment of abdomen is entirely, and the apical segment partly black; but specimens of *A. guttulus* frequently vary in colour of head and abdomen.

Astenus indicus, Kraatz.

I asked Mr. G. J. Arrow to kindly compare the types of *A. aequalis, A. pallidulus,* and *A. indicus.* In reply he wrote: "I have compared the types of *aequalis*, Blackb.; *pallidulus*, Woll; and *oculatus*, Sharp, with a specimen from Ceylon received from Kraatz as *S. indicus,* and I believe all to be the same."

Astenus pectinatus, Fvl. Fig. 29.

An apterous male, taken from rotting leaves on Mount Tambourine, has such a remarkable comb on the under-surface of its abdomen that I think it is either an immature specimen of this species (described originally as from Sydney), or represents a variety of it; the comb is composed of about twenty long, shining, black bristles, and extends across almost the entire width of the antepenultimate segment. Its elytra are decidedly shorter than the prothorax, their apical half is flavous, and the basal half slightly darker than the prothorax, with the sides strongly rounded, and the comb-bearing segment is slightly infuscated at the base of its upper-surface. The mandibles are much as I have figured them for *A. noctivagus.*

Astenus noctivagus, n. sp. Fig. 11.

♂. Piceous-brown or black; mouth parts, mandibles, antennae, palpi, and legs flavous, tips of elytra, and of most of the abdominal segments obscurely flavous. Clothed with very minute ashen pubescence, sides of head and of prothorax with a few stiff setae, sides and tip of abdomen with longer hairs.

Head rather large; with shallow reticulate punctures. Mandibles long and acute, each about middle with a long acute tooth, which is itself dentate. Antennae thin, none of the joints transverse. Prothorax dilated to near apex, and then strongly narrowed to apex itself, which is narrower than base. Elytra slightly longer than prothorax and conspicuously wider, angles gently rounded, sides almost parallel; with dense and sharply-defined punctures. Abdomen with dense and small punctures, subapical segment triangularly notched at apex of under-surface. Length, 3.5-4 mm.

♀. Differs in having the head and prothorax somewhat smaller, and abdomen not notched.

Hab.—Queensland: Cairns, nine specimens obtained at lights (A. M. Lea); New South Wales: Sydney (Dr. E. W. Ferguson). Type, I. 12402.

Close to *A. apiciflavus*, but apex of elytra narrowly pale, instead of widely flavous; the pale portion being only about one-third that of *apiciflavus*, and hardly more than that of the tips of the abdominal segments. On several specimens the elytral suture is obscurely diluted with red. On several the head and prothorax are almost black, on others they are of a more or less dingy brown; they are really opaque, but the elytra and abdomen are shining, although the derm is partially concealed by the clothing. Ample wings are present.

Astenus majorinus, n. sp.

♀. Black; mouth parts, mandibles, antennae, palpi, and legs flavous. Clothed with very short ashen pubescence, the sides with a few stiff setae. Length, 5.25-6.75 mm.

Hab.—Queensland: Cairns district (A. M. Lea). Type, I. 12404.

Allied to the preceding species, and structurally as described, but considerably larger, antennae distinctly longer and thinner, each joint being at least twice as long as wide; on the preceding species each of the sixth to tenth joints is not much longer than wide. It is of the size of *A. favosus,* but is winged. The abdomen is really black, but owing to the clothing has a rusty appearance. A male belonging to the species is evidently immature, it differs from the type in being of a dingy red, with the tips of elytra and parts about the scutellum obscurely paler; the tip of its subapical segment is triangularly notched. Three specimens were obtained at lights.

Astenus mandibularis, n. sp. Figs. 12 and 13.

♂. Reddish-castaneous; mouth parts, mandibles, antennae, palpi, apex of elytra, legs, and most of abdomen flavous, an interrupted fascia on elytra, upper-surface of fourth segment of abdomen, and of part of seventh, black or blackish. Sparsely clothed with short pale pubescence, the sides with rather long dark setae or hairs.

Head rather large; with shallow reticulate punctures. Mandibles long and acute, the left one with an acutely bicuspidate tooth before the middle, the right one in addition with a minute tooth beyond the middle. Antennae thin, first joint as long as three following combined, ninth and tenth scarcely longer than wide. Prothorax scarcely longer than the greatest width, which is near apex, sides obliquely narrowed to near base, and strongly rounded to apex, punctures as on head. Elytra distinctly longer and wider than prothorax; with dense sharply-defined punctures and a few obtuse granules. Abdomen less than half the total length, subapical segment triangularly notched almost to base on under-surface. Length, 4.25-4.75 mm.

Hab.—Queensland: Cairns district (A. M. Lea). Type, I. 12411.

The elytral fascia is of irregular shape, and touches neither suture nor sides, the space posterior to it is considerably paler than that anterior to it, although the latter is not of so bright a red as the prothorax. In appearance fairly close to some forms of *A. brevicollis,* but the dark elytral markings confined to a median space (and very conspicuous there), the elytra with fewer subgranular elevations, the prothorax somewhat longer, and only one abdominal segment dark, and that on the upper-surface only. From the description of *A. pectinatus* it differs in being larger, elytra paler beyond than before the black markings, and the fourth segment of abdomen black. It is much larger than *A. guttulus,* elytra with black markings irregularly transverse, and their apex pale.

A female (from North Queensland, Blackburn's collection) differs from the type in having the head and prothorax almost black, the elytra black except at the apex, and the fifth segment of abdomen the only conspicuously pale one; it agrees in many details with the description of *A. (Dibclonetes) antipodum,* but differs in the abdomen, although at first glance the three basal segments appear to be as dark as the fourth, in certain lights they are seen to be distinctly less dark. It, and the type (a third specimen has the mandibles clenched) have the mandibles, side for side, exactly alike.

Astenus ambulans, n. sp. Fig. 14.

♀. Pale castaneous; antennae, palpi, and legs flavous, basal two-thirds of fifth segment of abdomen black. Very minutely pubescent; the sides with sparse black setae, becoming numerous about apex of abdomen.

Head rather large; with shallow reticulate punctures. Mandibles long and acute, each near middle with a long acute tooth, and which has a minute basal projection. Antennae thin, some of the median joints not much longer than wide. Prothorax very little longer than the greatest width, which is near apex,

sides strongly rounded to apex; punctures as on head. Elytra rather narrow, less than the greatest width of prothorax, shoulders rounded; with dense and sharply-defined punctures. Abdomen somewhat dilated posteriorly, where the greatest width is equal to that of head; punctures fairly dense and sharply defined on under-surface, less sharply on the upper. Length, 3.25-3.5 mm.

Hab.—New South Wales: Ourimbah, from rotting leaves (A. M. Lea).

The elytra are almost parallel-sided, but are small and do not cover wings (I have dissected two specimens to be sure of this); their apical half is paler than the basal half, but the two shades of colour are not sharply limited; on each side near the base, and invisible from above, there is a slight infuscation, part of the metasternum is also slightly infuscated. At first glance the specimens look like rather narrow ones of *A. indicus*, but that species is winged; they are narrower and less opaque than the specimens I have identified as belonging to *A. australicus*, and the elytral punctures are much more sharply defined

A male (from Ulverstone, Tasmania) is evidently an immature specimen of the species; it differs from the type in being smaller, very pale castaneous, no parts black or infuscated, the two shades of colour on the elytra still less defined, the joints of the antennae somewhat longer, the under-surface of the fifth segment of abdomen with a shallow subapical depression, and the sixth deeply incised

Astenus tardus, n. sp.

♂. Pale flavo-castaneous; antennae, palpi, elytra, and legs pale flavous. Clothed with very short whitish pubescence, and with long, straggling, black hairs

Head rather large; with shallow, reticulate punctures Antennae thin, none of the joints transverse, but ninth and tenth very little longer than wide Prothorax scarcely as long as greatest width (near apex), which is almost equal to that of head, sides strongly but unequally rounded; punctures much as on head Elytra slightly wider and slightly longer than prothorax; with dense and sharply-defined punctures, and with a few rows of feeble piliferous granules Abdomen rather wide; with denser punctures than on prothorax, but smaller and less sharply defined; subapical segment with a deep, triangular notch Length, 3.75 mm.

Hab.—Queensland: Mount Tambourine (A M. Lea). Type (unique), I. 12406.

From some directions the upper-surface of the abdomen, as well as the elytra, appear to have feeble rows of granules, but they are placed transversely. The species in general appearance is strikingly like Form I of *A brevicollis*, but it is apterous; it is considerably wider than the preceding species, and the elytra are granulate The mandibles of the type were broken in manipulating them for examination

STILICOPSIS, Sachse, Cat., p. 220.

TRINOTATA, Kraatz. Q. Introduced.

STILICUS, Latr., Cat., p. 223.

ORBICULATUS, Payk. Tas. Introduced.

STILICUS ORBICULATUS, Payk.

A specimen, from Launceston, agrees perfectly with British specimens of this species; a widely distributed one, but now first recorded as Australian; five synonyms and varieties of the species are recorded in the catalogue.

Stilicus umbratus, n. sp.

♂. Dull reddish-brown; head and prothorax much darker (somewhat bronzy), mandibles, antennae, palpi, and legs flavous, or castaneous-flavous. With very short ashen pubescence, and with a few dark hairs scattered about.

Head rather large, moderately convex, and distinctly transverse, hind angles strongly rounded, neck very thin; punctures small and densely crowded, under-surface shagreened and with conspicuous punctures. Mandibles strong, acutely tridentate. Antennae extending to base of prothorax, first joint longer than second and third combined, second as long as fourth, and distinctly shorter than third, the others to tenth gradually becoming shorter and more globular. Prothorax much narrower than head, hind angles strongly rounded, sides moderately dilated to near apex, and then strongly obliquely narrowed to neck; punctures much as on head. Elytra quadrate, longer and much wider than prothorax; with small crowded punctures, somewhat larger than on head and prothorax, and with large ones scattered about, and forming irregular rows. Under-surface of apical and subapical segments of abdomen notched in middle. Front femora very feebly dentate, front tibiae slightly notched about middle, front tarsi slightly wider and shorter than the others. Length, 4.25-4.5 mm.

♀. Differs in having the abdomen slightly wider and not notched, head slightly wider, and antennae and legs slightly shorter.

Hab.—Queensland: Cairns district and Mount Tambourine, sieved from rotting leaves (A. M. Lea). Type, I. 12637.

About the size of *S. orbiculatus,* and with somewhat similar outlines, except that the prothorax is more transverse, the head shorter, and antennae longer, the finer sculpture and the colours, however, are very different. The head and prothorax have an appearance as of dull bronze on the upper-surface, and of some specimens on the under-surface also; the elytra are usually paler than the abdomen, and the larger punctures, usually being darker than the adjacent surface, give them a speckled appearance; on several females almost the whole of the under-surface is not much darker than the legs; the elytra and abdomen usually have a faint coppery or bronzy tinge. The elytra are shining, the rest of the upper-surface opaque. The pubescence on the head and prothorax is extremely short and inconspicuous. The prothorax at first appears to be more transverse than it really is, owing to the sudden narrowing of the front to the neck; it is very feebly ridged along the middle, with two shallow depressions on each side of the ridge. The punctures on the head and prothorax are very small, but may be seen on close examination, on the abdomen they are so extremely small that the surface appears shagreened; many of the large punctures on the elytra are irregularly conjoined, so as to present the appearance of irregular striae; near the suture they are mostly isolated. The only specimen before me, from Mount Tambourine, has the whole of the upper-surface very dark (almost black) except that the tip of the abdomen is obscurely reddish; its elytra appear finely granulate, and with the large punctures more numerous than on the others; one from Cairns has the elytra and abdomen darker than usual, although paler than on the one from Mount Tambourine.

THINOCHARIS, Kraatz, Cat., p. 228.

BREVICORNIS, Fvl. Q. (also occurs in New Guinea).

TENUICORNIS, Lea *(Lithocharis)*, Proc. Roy. Soc. Vict., 1909, p. 122. Q., N.W.A.

THINOCHARIS TENUICORNIS, Lea.

There are before me nine specimens, taken from rotting leaves at Mount Tambourine, that appear to belong to this species; they differ, however, from

the types in being shining and paler; on five of them the elytra and legs are pale flavous, the prothorax slightly darker, and the head slightly more reddish, but certainly not dark; on the others the elytra are as dark as the prothorax, and the head is distinctly darker but more castaneous than piceous. The species in appearance somewhat resembles *Medon debilicornis*, but it is at once distinguished by the antennae, the joints after the second on that species are comparatively short and transverse, on the present species they are decidedly longer and thinner, so that if drawn backwards the antennae would extend to the base of the prothorax, instead of scarcely to the middle. The subopaque appearance of the types may have been due to improper treatment; if it is natural the Queensland specimens should probably be regarded as representing a variety, or a distinct species.

MEDON, Steph., Cat., p. 231.

(*Hypomedon*, Muls. et Rey, p. 238; *Lithocharis*, Bois. et Lac., p. 241; and *Pseudomedon*, Muls. et Rey., p. 240, are subgenera.)

CAMPONOTI, Lea (*Lithocharis*), Proc. Roy. Soc. Vict., 1912, p. 41. Q., N.S.W.
CINCTUS, Fvl. (*Hypomedon*). Q. (also occurs in New Guinea).
DEBILICORNIS, Woll. (*Hypomedon*). Q., N.S.W., S.A., N.T., Norfolk Island. Introduced.
IGNITUS, Fvl. (*Hypomedon*). Q.
INCOMPTUS, Sharp (*Lithocharis*, *Ophiomedon*, and *Hypomedon*), Cat., p. 230. Q. Introduced.
LINDI, Blackb. (*Lithocharis*). S.A., W.A.
OBSOLETUS, Nordm. (*Pseudomedon*). Q. Introduced.
OCHRACEUS, Grav. (*Lithocharis*). Q., N.S.W., V., Tas. Introduced.
TRISTIS, Macl. (*Lithocharis*). Q., N.S.W., N.T., Lord Howe Island.
VARICORNIS, Blackb. (*Lithocharis*). V.
VILIS, Kraatz (*Lithocharis*). Q. Introduced.

MEDON OBSOLETUS, Nordm.

Several specimens were obtained from fallen leaves, at Cairns, that appear to agree perfectly with British and European specimens of this species. It was first recorded as Australian in the catalogue by Bernhauer and Schubert, and eight synonyms and varieties are there noted.

MEDON OCHRACEUS, Grav.

This cosmopolitan species was apparently first recorded as Australian in the same work as the preceding one; Australian specimens before me are from Queensland (where it is frequently attracted to lights) and Tasmania. Six synonyms of the species are recorded.

MEDON DEBILICORNIS, Woll.

Widely distributed in Australia, although first noted as Australian in the catalogue by Bernhauer and Schubert, who record four synonyms of it. A rather highly-coloured figure of the species is given under the name of *Lithocharis brevicornis*.[18]

MEDON VARICORNIS, Blackb.

This is probably only a slight variety of *M. tristis*.

MEDON CAMPONOTI, Lea.

Six specimens of this species were taken from a nest of *Camponotus aeneopilosus* at Glen Innes.

(18) Allard, Ann. Soc. Ent. Fr., 1857, pl. 14, Part 2.

MEDON INCOMPTUS, Sharp.

A cotype of this species, from Hawaii, is in the South Australian Museum. Sharp described the elytra as "in medio transversim obscuratis," and again "with a dark cloud across the middle"; the cotype has the dark part so placed that it leaves almost the apical half pale and sharply defined, with a part of the base paler than the infuscated portion, but not sharply divided from it. Two specimens from Northern Queensland are structurally identical with the cotype, but differ to a slight extent in the elytral marking, both from it, and from each other. One from Kuranda in the British Museum has the basal two-thirds of prothorax blackish, but apparently from staining.

Sharp considered the species as allied to the American *Lithocharis compressa,* and that it was "probably a native of some part of the American continent." In the catalogue both species are referred to *Ophiomedon*, but *L. incomptus* appears to me to be clearly allied to *Medon (Hypomedon) debilicornis.*

MEDON, sp.

Two specimens (sexes) of a species from Queensland (one was taken from a sticky seed of *Pisonia brunoniana* at Cairns) possibly belong to *M. (Charichirus) chinensis,* Boh.[10] Structurally the female agrees perfectly with an Indian female, received with the name from Dr. Cameron, except that the front tibiae are rather more dilated to apex. The male has the (apparent) fifth segment of its abdomen widely and shallowly concave on its under-surface, with the apex conspicuously incurved to middle (the following segments are contracted within the body); the space between the eyes on the under-surface of its head is densely and somewhat coarsely punctate (on the female the derm there is but finely punctate). The Queensland specimens have the reddish apical part of the elytra fairly wide on each side and narrowed to the suture, instead of dilated there as on the Indian one; so possibly the species is not *chinensis,* but an allied one.

In his diagnosis of *Charichirus* Sharp says, "*Tarsi omnes graciles, anteriores simplices*"; but on the Indian and Queensland specimens before me the four basal joints of the front tarsi are dilated so as to be almost twice as wide as those of the other tarsi.

Medon quadratipennis, n. sp.

♂. Black or blackish; mouth parts, antennae (the median joints infuscated), palpi, legs, under-surface of head and sterna more or less red, tip of abdomen obscurely reddish. With fairly dense ashen pubescence, sparser on prothorax than elsewhere, and with some rather short hairs scattered about.

Head between front of eyes and neck rather strongly transverse, sides almost parallel, hind angles scarcely rounded off; with dense and minute punctures, sparser (but still dense) and more sharply defined between antennary tubercles than elsewhere. Antennae passing base of prothorax, first joint subcylindrical, slightly longer than second and third combined, fourth slightly longer and thinner than second, and shorter than third, the others to tenth feebly decreasing in length and increasing in width, ninth and tenth transverse. Prothorax feebly transverse, width about equal to that of head, sides slightly decreasing in width to base, with a faint median line; punctures much as on head. Elytra quadrate;

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(10) The references in the catalogue by Bernhauer and Schubert are on pp. 231 and 243. Subgenus CHARICHIRUS, Sharp, Ann. Mag. Nat. Hist. (6), II. (should be III.), 1889, p. 262.

CHINENSIS, Boh.
obliquus, Walker.
spectabilis, Kraatz; Sharp, *l.c.,* p. 227 (should be 263).
China, Japan, India, Ceylon, etc.

with very dense and minute punctures. Tip of abdomen notched on both surfaces. Front femora stout and edentate; front tibiae notched at about basal third; front tarsi with four basal joints slightly inflated (about twice the width of the others), basal joint of hind tarsi slightly longer than the two following combined. Length, 4-4.25 mm.

♀. Differs in having the head and prothorax slightly narrower, legs and antennae slightly shorter and abdomen not notched.

Hab.—Tasmania: Hobart from a tussock, Nubeena, Huon River (A. M. Lea); Victoria: Warburton in August (F. E. Wilson).

A dingy subopaque species, at first glance apparently belonging to *M. lindi*, or *M. tristis*, but elytra decidedly smaller (at most as long as wide, they are very little longer than the prothorax and scarcely as wide as its widest part); on *lindi* and *tristis* they are decidedly longer than wide, distinctly longer and conspicuously wider than the prothorax. I have made sure that wings are folded beneath the elytra. Of the six specimens before me most have the prothorax as dark as the head, but on one specimen it is obscurely reddish; the hind femora and tibiae (except the knees) are usually darker than the rest of the legs.

A male, taken from flood *debris* at Latrobe, appears to belong to this species, but differs in having the elytra flavous, except that their basal third is rather deeply infuscated.

Medon lugubris, n. sp. Figs. 15 and 16.

♀. Of a dingy opaque-brown; mandibles, palpi, and legs paler. With rather long, straggling, dark hairs, elytra and abdomen with dense ashen pubescence, becoming very inconspicuous on head and prothorax.

Head strongly transverse between front of eyes and neck, hind angles feebly rounded off; punctures minute and very dense. Mandibles long, acute, and strongly dentate. Antennae slightly passing base of prothorax, first joint as long as second and third combined, second slightly wider and very slightly shorter than third, ninth and tenth slightly transverse. Prothorax distinctly wider than long, rather closely applied to and slightly wider than head, front angles almost square, hind ones strongly rounded, with a very narrow but continuous median line; punctures as on head. Elytra at base slightly wider than widest part of prothorax, and very feebly dilated to near apex, at least half as long again as the prothorax, and with somewhat similar punctures. Abdomen with dense and very minute punctures. Front femora stout and edentate, front tarsi slightly wider and shorter than the others. Length, 4-4.25 mm.

Hab.—Queensland: Cairns district from fallen leaves (A. M. Lea), attached to a sticky seed of *Pisonia brunoniana* (F. P. Dodd). Type, I. 12635.

An unusually flat opaque species, about the size of *M. ochraceus*, but otherwise very different; it perhaps belongs to the subgenus *Charichirus*. The type has the head slightly paler than the prothorax, and the front angles of prothorax and base of elytra paler than the adjacent parts, but the two shades of colour not sharply limited. The specimen from *Pisonia* seed has the upper-surface almost black, except that the shoulders are inconspicuously reddish, and the legs and other appendages of a dingy red; on each specimen the apex of the (apparent) fifth segment of abdomen is obscurely pale. On both specimens there are four teeth on the right mandible and three on the left. From some directions the head, prothorax, elytra, and metasternum appear to be very densely and evenly granulate; the prothorax from some directions appears to have some of the punctures longitudinally confluent. The granulation of the under-surface of the head, including the mentum, is rather more conspicuous than on the upper-surface, the gular suture appears single for its greater extent.

Medon uniformis, n. sp.

Pale reddish-castaneous; antennae, palpi, and legs flavous. Elytra and abdomen with rather dense and somewhat golden pubescence, much less distinct on head and prothorax.

Head distinctly transverse, hind angles gently rounded off, with a very narrow median line; punctures dense and very minute. Antennae short, second joint slightly longer than third, the following ones to tenth feebly increasing in width and mostly transverse. Prothorax transverse, front angles almost square, the hind ones strongly rounded; punctures as on head. Elytra slightly longer than wide, slightly wider than widest part of prothorax, about once and one-half its length, and with somewhat larger and more sharply-defined punctures. Legs not very long, front femora stouter than the others and very feebly dentate. Length, 3.5-3.75 mm.

Hab.—Queensland: Mulgrave River (H. Hacker).

A small, pale, subopaque species, certainly close to *M. debilicornis* (and consequently belonging to the subgenus *Hypomedon)* but more opaque, larger, head conspicuously larger and less closely applied to the prothorax (owing to the longer neck); the elytra also, although slightly paler than the prothorax, are simply paler, rather than flavous. I have checked the types with a cotype and some other specimens of *debilicornis* from Hawaii, India, and Japan (identified by Drs. Cameron and Sharp), and the differences appear constant. It is about the length of *M. incomptus,* but is less robust and elytra not conspicuously bicoloured, being at most very feebly infuscated about the scutellum. *M. ignitus,* another almost uniformly coloured species, is described as being smaller, 3 mm., and with strong punctures; although in the description only the abdomen is mentioned as *"laeviusculo,"* in the table the species is associated with *M. cinctus* as having *"Corps tres brillant,"* whereas this species is very dull. The tip of the abdomen of each of the types is contracted, but on one of them (evidently a male) part of a notch is visible; from the other the notch appears to be absent. The middle of the prothorax is slightly produced to form (apparently) part of the neck; it has a very feeble median line, of which the only fairly distinct portion is a short shining line near the base. Except on the abdomen there are very few hairs scattered about.

SCOPAEUS, Er., Cat., p. 245.

BLACKBURNI, Bernh. and Schub. N.S.W.
femoralis, Blackb., n. pr.
DIGITALIS, Fvl. V., Tas., S.A., W.A.
DUBIUS, Blackb. Q., N.S.W., V.
INTEROCULARIS, Lea, Proc. Roy. Soc. Vict., 1912, p. 41. N.S.W.
LATEBRICOLA, Blackb. N.S.W., V., S.A.
OVICEPS, Bernh., Arkiv. for Zool., xiii. (No. 8), p. 13. Q., N.T.
OVICOLLIS, Macl. *(Stilicus).* Q., N.S.W.
ruficollis, Fvl.
OBSCURIPENNIS, Blackb. Q., N.S.W., V., S.A., W.A., C.A.
SULCICOLLIS, Steph. Q. Introduced.

SCOPAEUS OVICEPS, Bernh.

A specimen, from the Daly River, probably belongs to this species, but differs from the description in having the head and prothorax of a very dark castaneous-brown, although appearing black at a glance.

SCOPAEUS DUBIUS, Blackb.

Five specimens from New South Wales and Victoria (one was taken from a nest of the ant *Dolichoderes scabaridus)* appear to belong to this species, but

differ from the description in having most of the joints of antennae slightly transverse, and the median ones slightly infuscated.

Scopaeus ctenocryptus, n. sp.

♀ Shining black; mouth parts, mandibles, antennae, palpi, and legs (femora darker) pale brown or testaceous. With very short ashen pubescence, denser on abdomen than elsewhere.

Head ovate, strongly rounded towards base and with a small narrow neck, depressed between antennae. Mandibles strong and acutely dentate. Eyes rather large. Antennae long, passing base of prothorax, first joint cylindrical, as long as second and third combined, third distinctly longer than second and fourth, the others gradually decreasing in length to tenth, but none transverse. Prothorax dilated from base to slightly in advance of middle, and then strongly narrowed to apex, which is the same width as the neck, a short median carina at the base, on each side of which is a shallow depression. Elytra much wider than prothorax, and slightly longer than prothorax and neck combined, angles strongly, the sides slightly rounded. Legs rather long, femora edentate. Length, 3 75-4 mm.

Hab.—Queensland: Mulgrave River (H. Hacker).

A black species, but differs from *S. digitalis* in being larger, head of somewhat different shape, with larger eyes, antennae much longer, with no joints transverse and at least five decidedly pale; the basal half of the antennae is distinctly darker than the apical half. The under-surface, especially of the abdomen, is not as dark as the upper-surface. The upper-surface of the abdomen is less shining than the other parts, owing to its denser clothing. The punctures are very minute, scarcely visible under a hand lens. There is a notch (invisible from many directions) at about the basal third of the front tibiae, and this is supplied with a comb of numerous small teeth, but the comb is so placed as to be visible with difficulty even under a compound power; under a hand lens it appears as an oblique ridge.

Scopaeus moerens, n. sp.

♂. Black; tarsi and parts of palpi obscurely paler.

Head between antennae and neck about as long as wide, hind angles gently rounded off. Antennae scarcely passing base of prothorax, first joint as long as second and third combined, fifth to tenth transverse. Prothorax distinctly longer than wide, apical third strongly narrowed to neck, a small median elevation at base. Elytra conspicuously wider and longer than prothorax, parallel-sided except at angles. Under-surface of abdomen notched in middle of apex of apparent sixth and seventh segments. Legs not very long, femora stout, the front ones feebly dentate; front tibiae notched and with a small comb at about basal third. Length, 2.25-2.5 mm.

♀. Differs in having the head slightly smaller, antennae and legs slightly shorter, and abdomen not notched.

Hab.—Western Australia: Newcastle, Darling Ranges, and Pinjarrah (A. M. Lea).

A very small species, in general appearance close to *S. latebricola*, but smaller and darker; *S. digitalis* is larger, with conspicuously pale tarsi. On some specimens the front legs are of a dingy brown, and on such the labial palpi are flavous; but at first glance the species appears to be entirely black. The head and prothorax are more shining than the other parts, but this is due to the very fine pubescence being sparser there than elsewhere. The punctures of the upper-surface are very dense and small, scarcely visible under a hand lens.

Scopaeus testaceipes, n. sp.

♀. Dark piceous-brown, most of abdomen black, basal and apical joints of antennae (the others slightly infuscated), palpi (except apparent apical joint of maxillary palpi) and legs pale brown or testaceous. Length, 2.25 mm.

Hab.—Victoria: Warburton, in August (F. E. Wilson), Bright (National Museum, from C. French). Type, I. 12861.

Close to the preceding species, and the description of the sculpture of the head, prothorax, and elytra applies equally well to the present one, but the prothorax is not so black, the antennae and legs are paler, with the median joints of the former slightly infuscated, the prothorax of the present species is also slightly wider, and the median elevation at its base is slightly larger. There are six of the preceding species before me, and three of the present, so the differences would appear to be constant. The front femora are feebly dentate, and the front tibiae are notched towards the base, but although a comb is probably there I have been unable to see it under the microscope.

Scopaeus mediicollis, n. sp.

♀. Pale castaneous-brown; antennae, palpi, and legs still paler, most of abdomen (both surfaces) infuscated.

Head subquadrate between antennae and neck (the latter very small). Eyes lateral and rather small. Antennae scarcely passing base of prothorax, first joint almost as long as three following combined, second no shorter than third and slightly stouter, fourth to tenth subglobular and slightly transverse. Prothorax slightly longer than wide, sides very feebly dilated from base (except for the rounded angles) to near apex, and then strongly narrowed to neck, with a shining median line almost throughout. Elytra not much wider than prothorax and very little longer. Front femora stout and feebly dentate, front tibiae slightly notched towards base. Length, 2-2.25 mm.

Hab.—Western Australia: Vasse River, in flood *debris* (A. M. Lea).

A flat minute species, smaller and flatter than *S. latebricola*, outlines of prothorax more angular, and with an almost continuous, shining, median line. On the type there is a slight infuscation about the base of the elytra, and its metasternum is as dark as the abdomen; on a second specimen the elytra and metasternum are no darker than the prothorax. The punctures and pubescence are both very minute, and scarcely visible under a hand lens; the former are slightly more conspicuous on the elytra than elsewhere.

A male, from the Swan River, that possibly belongs to this species differs from the type in being of a rather brighter colour and more shining (probably due to abrasion), the median line on the prothorax is more conspicuous, and the elytral punctures are (for the genus) rather sharply defined, the antennae are evidently longer, and fewer of the joints are transverse (but several are missing); the apparent sixth and seventh segments of its abdomen are deeply notched on the under-surface.

Scopaeus basicollis, n. sp.

♀. Bright reddish-castaneous; antennae, palpi, and legs flavous, part of elytra and most of upper-surface of abdomen infuscated. Pubescence very short and pale, rather dense on abdomen, sparser on head and elytra, very sparse on prothorax.

Head between antennae and neck distinctly transverse, hind angles rather strongly rounded, neck very small. Antennae with first joint as long as second and third combined, second the length of third and slightly stouter, fourth to tenth subglobular and gradually becoming transverse. Prothorax elliptic-ovate, apical third strongly narrowed to neck, a small median elevation at base, with

a conspicuous impression each side of it. Elytra much wider and slightly longer than prothorax, almost parallel-sided except for the rounded angles. Front femora fairly stout, scarcely visibly dentate; front tibiae notched at about one-third from base. Length, 2.75-3 mm.

Hab.—Queensland: Cairns district, five specimens obtained at lights (A. M. Lea). Type, I. 12860.

In general appearance close to *S. dubius* and *S. ovicollis*, but larger and base as well as apex of elytra pale, so that on several specimens the elytra appear to have a conspicuous infuscate fascia, and others to have a large spot on each, the dark parts not very sharply limited. The middle of the head is of the same bright colour as the prothorax, but the rest of its upper-surface is somewhat darker. On most of the specimens the median joints of the antennae are very feebly infuscated. There are some fairly distinct punctures on the front part of the head, and on the elytra they are rather sharply defined, although small; elsewhere they are scarcely visible. There are some sharp teeth on the mandibles, but these, as on other species of the genus, are usually so tightly clenched that it is difficult to force them out for examination. There is evidently a comb on the front tibiae, but I have been unable to see it clearly.

Scopaeus ooderes, n. sp.

♀ Reddish-castaneous; antennae, palpi, and legs paler, four basal segments of abdomen and part of the fifth, and the metasternum infuscated. Moderately clothed with very short ashen pubescence.

Head between antennae and neck (the latter very small) subquadrate, hind angles but feebly rounded; with very dense and small punctures. Eyes rather small and prominent. Antennae with first joint subcylindrical, as long as three following ones combined, second stouter and slightly longer than third, third to tenth subglobular, gradually becoming feebly transverse. Prothorax longer than wide, elliptic-ovate, apical third strongly narrowed to neck; punctures as on head. Elytra slightly longer and much wider than prothorax, and with slightly larger and more sharply-defined punctures. Abdomen (both surfaces) with very dense and small punctures. Front femora rather stout and very feebly dentate, front tibiae notched at about one-third from base. Length, 3.75 mm.

Hab.—Western Australia: Donnybrook (A. M. Lea). Unique.

Differs from type of *S. interocularis* in being somewhat larger, pale parts somewhat darker, the head uniformly coloured, metasternum almost as dark as abdomen and darker than rest of under-surface, and punctures of upper-surface more distinct. On close examination the median joints of antennae are seen to be slightly darker than the others, but they could scarcely be regarded as infuscated. The prothorax has a medio-basal elevation, but it is very feeble and invisible from most directions. The punctures on the under-surface of the head are dense, sharply defined, and slightly larger than those on the elytra, on the upper-surface between the antennae they are almost as large as those on the elytra.

Scopaeus flavocastaneus, n. sp.

♂. Pale flavo-castaneous and subopaque; head slightly darker, palpi and legs slightly paler. Almost uniformly clothed with very short ashen pubescence.

Head between antennae and neck (the latter very small) subquadrate, hind angles slightly rounded. Eyes small and prominent. Antennae rather long, first joint cylindrical, slightly longer than second and third combined, second as long as fourth and conspicuously shorter than second, eighth to tenth globular. Prothorax rather flat, not much longer than greatest width, which is about one-fourth from apex, from there strongly narrowed to neck. Elytra about the width of head and distinctly longer than prothorax. Under-surface of

abdomen with apparent sixth and seventh segments triangularly notched to base. Legs not very long, front femora stout and scarcely visibly dentate; front tibiae feebly notched at about one-third from base. Length, 3.75-4 mm.

♀. Differs in having slightly shorter antennae and legs, and abdomen not notched.

Hab.—Northern Territory: Oenpelli (P. Cahill); Queensland: Cairns district, to light; New South Wales: Tweed River (A. M. Lea). Type, I. 12639, in South Australian Museum; cotype in National Museum.

A pale almost opaque species, slightly above the average size of species of this genus and like *Domene australiae* in miniature, and much like *D. microps*, but without the remarkable front tibiae of those species. In some respects it apparently resembles *S. blackburni*, but the front legs are without conspicuous armature. From the preceding species it differs in being wider, with smaller punctures, especially on the under-surface of head, antennae longer, with the third joint conspicuously longer than second, abdomen no darker than elytra, etc. The punctures are everywhere dense, and too small to be seen clearly under a hand lens. There are remnants of a medio-basal elevation on the prothorax, with a depression on each side of it, but they are so feeble as to be invisible from most directions, and distinct from none.

DOMENE, Fvl., Cat., p. 253.

AUSTRALIAE, Fvl. Q., N.S.W., N.T. TORRENSENSIS, Blackb. S.A.

DOMENE AUSTRALIAE, Fvl.

Two specimens (5-6.5 mm.), from New South Wales, that appear to agree with the description of this species, differ from a cotype, and some other Adelaide specimens of *D. torrensensis*, in having the elytra somewhat shorter, the prothorax flatter, and without a median elevated line. The differences mentioned are distinct on seven specimens of *torrensensis*, and two of *australiae*, but are possibly only of varietal importance; if synonymous the latter has precedence. A specimen from Oenpelli, in the National Museum, has elytra of the same proportionate length as in *torrensensis*, but its prothorax is narrower and median line less conspicuous.

DOMENE TORRENSENSIS, Blackb.

Mr. H. H. D. Griffith took several specimens of this species during a flood on the Torrens River. Two of them are males, and have on the under-surface of the apparent fourth segment of abdomen a large and almost circular depression, on the following segment there is a wider and almost parallel-sided one, and the following segment is narrowly notched to the base itself.

Domene pectinatrix, n. sp. Fig. 30.

♂. Dark brown; head still darker, legs paler, mandibles black. Densely clothed with short ashen pubescence, and with a few hairs scattered about.

Head fairly large and ovate, hind angles strongly rounded, neck very small, antennary tubercles highly polished. Eyes rather small, prominent, and with coarse facets. Antennae rather stout, first joint cylindrical, about as long as second to fourth combined, the following ones to tenth subglobular. Prothorax about as long as head to mandibles, and distinctly narrower, hind angles strongly rounded, apical third triangularly narrowed to neck, with a very narrow median line, slightly elevated above the general surface near base, and with a very narrowly impressed line about middle. Elytra slightly wider than head and slightly longer than prothorax. Abdomen with first segment very small, and with a

median ridge on under-surface continued on to second, sixth rather shallowly notched at apex, and with a comb of short teeth there, seventh more deeply and triangularly notched. Legs moderately long; front femora stout, obtusely dentate, and with a comb; front tibiae triangularly dilated about base, the underside of the dilated part with three golden combs. Length, 9.5-10 mm.

♀. Differs in being slightly less robust, in having the head slightly smaller, antennae slightly shorter and thinner, and abdomen not notched and combless.

Hab.—Northern Territory: Oenpelli (P. Cahill). Type in National Museum.

There are nine combs on the male of this remarkable but dingy insect, four on each of the front legs, and one on the abdomen. In a good light and from certain directions three, composed of numerous, short, close-set golden teeth, may be seen on each front tibia, the combs parallel with each other, with the teeth of the first and second terminating just before the beginning of the second and third, attached to the third one there are also some long bristles; the front femora each have a narrow ridge extending from the base to about the apical third, where it abruptly terminates with the appearance of a fairly strong tooth, the edge of which curves around and is supplied with a somewhat similar comb to those on the tibiae; the comb on the abdomen of the type is lopsided, commencing gently on one side of the notch and ending abruptly on the other, the teeth, about twenty in number, from some directions appear of a beautiful golden-red, but from other directions of the same colour as the adjacent parts. On the right mandible, slightly in advance of the middle, there is a fairly large acute tooth, then a smaller acute one, and about the base two smaller obtuse ones; on the left mandible the basal tubercles are more acute and the others are not placed in sequence, but opposite each other, so that the teeth on the other side interlock with them when the mandibles are clenched. The punctures on the head are dense and rather small, but sharply defined, they are slightly larger in front, and denser at base than elsewhere, they are larger on its under-surface and sparser (but still dense) and more sharply defined than elsewhere; on the prothorax they are slightly smaller than on head, and about the base and median line still smaller, but sharply defined; on the elytra they are much as on base of head, on the abdomen (both surfaces) they are smaller and denser than elsewhere. The front part of the prosternum is finely transversely strigose. The remarkable structure of the front tibiae is much as in *Tripectenopus caecus* and *D. australiae*, from the latter it differs in being much larger, darker, punctures somewhat different, and prothorax narrower in proportion.

Domene microps, n. sp.

♀. Pale castaneous-brown; head slightly darker, legs slightly paler. Rather densely clothed with very short ashen pubescence.

Head between antennae and neck slightly longer than wide, sides almost parallel, hind angles slightly rounded, antennary tubercles shining. Eyes small and with coarse facets. Antennae rather stout, first joint slightly longer than second and third combined, second slightly longer than third, third to tenth subglobular and slightly transverse. Prothorax narrower than head and about as long, hind angles strongly rounded, apical third strongly narrowed to neck; with a narrow, shining, median line, itself with a very fine impressed line. Elytra slightly longer and distinctly wider than prothorax. Front femora stout and distinctly dentate, front tibiae with a triangular process at base, the process with three fine combs. Length, 3.25-3.5 mm.

Hab.—Northern Territory: Oenpelli (P. Cahill). Type, in National Museum; co-type, I. 15237, in South Australian Museum.

A subopaque dingy species, close to the preceding one on a greatly reduced scale, but apart from size, differs in being paler, head slightly longer, eyes smaller, and third joint of antennae as well as the following ones to tenth transverse. The comb on each front femur is rather looser than on that species, and the three on each front tibia are composed of slightly longer teeth, which on the first and second, touch, or slightly overlap, the base of the second and third. *D. australiae* and *D. torrensensis* are also much larger species, although much smaller than the preceding one. The punctures are as I have described them in the preceding species, but the insect being very much smaller, they are less clearly visible under a lens; the front part of the prosternum is also finely transversely strigose. The general appearance of the insect is strikingly close to *Scopaeus flavocastaneus* (of which both sexes are known), but the front legs are at once distinctive, the antennae are also stouter, with most of the joints transverse.

LATHROBIUM, Grav., Cat., p. 253.

ADELAIDAE, Blackb. N.S.W., S.A., C.A.
 spenceri, Blackb. (*Dolicaon*), Cat., p. 275.
ANGUSTICEPS, Fvl. Q., N.S.W., S.A., N.W.A., N.T., C.A.
 var. *semifumatum*, Lea, Trans. Roy. Soc. S. Austr., 1916, p. 494.
AUSTRALICUM, Sol. N.S.W., S.A.
BASIPENNE, Lea, *l.c.*, p. 495. N.S.W., S.A., C.A.
BREVICEPS, Fvl. Q.
CRIBRUM, Fvl. Q., N.S.W., V., Tas., S.A.
 var. *rufiventre*, Fvl.
EXIGUUM, Blackb. S.A.
FERREUM, Fvl. N.S.W.
GRATELLUM, Fvl. Q., N.S.W., V., S.A.
 elongatulus, Macl. (*Dolicaon*). Cat., p. 274.
LIMBATUM, Fvl. Q.
MICHAELSENI, Bernh. W.A.
MICROS, Fvl. Q., N.W.A.
MUTATOR, Fvl. Q., N.S.W., V., Tas., S.A., N.W.A., N.T.
 var. *bipartitum*, Fvl.
NOTATICOLLE, Fvl. Q., W.A., N.W.A., N.T., C.A.
PENNATUM, Fvl. Q., N.W.A.
POLITULUM, Macl. Q.
VICTORIENSE, Blackb. V.

LATHROBIUM AUSTRALICUM, Sol.

Blackburn referred this species to *Dicax*,[20] but I think it should remain in *Lathrobium*; its head is almost exactly as in *L. ferreum*, not as in the species of *Dicax*.

LATHROBIUM GRATELLUM, Fvl.

Dolicaon elongatulus, Macl.

Specimens that were compared and agree with the type of *Dolicaon elongatulus*, agree perfectly with the description of *L. gratellum*, except that they are somewhat larger, 5-5.75 mm. Fauvel appeared to have doubts as to *gratellum* really being distinct, but thought the description of the prothorax of *elongatulus* did not fit it. Macleay described it as "considerably longer than the breadth"; Fauvel as "tertia parte longiore quam latiore." Although Macleay's name was published before Fauvel's, the latter's name must stand, as *elongatulum* was used by Kraatz for a species of *Lathrobium* in 1858.

LATHROBIUM ANGUSTICEPS, Fvl.

L. semifumatum, Lea, var.

Two specimens from Stewart River (Queensland), and one from Sydney, agree with the description of *angusticeps*; they are structurally identical with

(20) Blackburn, Trans. Roy. Soc. S. Aust., 1902, p. 20.

semifumatum, and probably that form should be regarded as one of the many varieties of the species. Those before me vary from having the abdomen, except the tips, and head black or dull brown, prothorax almost as dark as the head or much paler, and elytra entirely pale to having a more or less large portion of the base infuscated.

LATHROBIUM CRIBRUM, Fvl.

A specimen, from Melbourne, agrees well with the description of this species; another, from Tasmania, agrees also with the description, but differs from the Melbourne specimen in being more robust, and the elytra larger, with slightly sparser punctures.

var. *rufiventre*, Fvl. Specimens of this variety are before me from Melbourne and Sydney.

LATHROBIUM MICROS, Fvl.

Two specimens, from Stewart River, agree with the description of this species, except that they are somewhat smaller, 3.75-4 mm.

LATHROBIUM LIMBATUM, Fvl.

A specimen, from Whitton (New South Wales), is probably an immature one of this species; it differs from the description in being slightly smaller (3.5 mm.), the head only slightly infuscated (it is, however, distinctly darker than the prothorax) and sixth segment of abdomen scarcely infuscated at the base. The punctures of its prothorax and elytra are somewhat unusual, but exactly as in the description.

LATHROBIUM EXIGUUM, Blackb.

A specimen of this species, in Mr. Elston's collection, has the prothorax conspicuously reddish, in strong contrast with the head; it was taken, in moss, in company with normally coloured ones.

LATHROBIUM ADELAIDAE, Blackb., 1886.

Dolicaon spenceri, Blackb., 1896.

I have compared the type of *D. spenceri* (belonging to the National Museum) with a cotype and other specimens of *L. adelaidae*, and find them identical. The latter was referred with some slight doubts to *Lathrobium*, the former, without comment, to *Dolicaon*. It is close to several species referred by Fauvel to *Lathrobium*.

Lathrobium orthodoxum, n. sp. Figs. 17 and 18.

♂. Shining black; basal joint of antennae, palpi, and legs (knees slightly infuscated) flavous, rest of antennae and mandibles somewhat darker. With rather short, black, erect setae, becoming longer about tip of abdomen, elytra and abdomen, in addition, with sparse ashen pubescence.

Head subquadrate (except for rounding off of angles) behind antennae; with fairly numerous and sharply defined, but not large punctures, sparser between eyes and denser on hind angles than elsewhere. Eyes rather small (less than the length of basal joint of antennae). Mandibles stout. Antennae rather long, first joint as long as second and third combined, third slightly longer than second and distinctly longer than fourth, the others to tenth smaller and more or less globular, eleventh about as long as second. Prothorax longer than wide, apex almost the width of head, sides slightly decreasing, with a very feeble incurvature to base, punctures slightly larger and denser than on head, but leaving a shining median line, a few minute ones scattered about. Elytra parallel-sided, distinctly wider and about one-half longer than prothorax; with small subrugose punctures. Abdomen with penultimate and ante-penultimate

segments notched at apex on under-surface. Front femora stout and feebly dentate; four basal joints of front tarsi stout, and forming a briefly ovate pad, basal joint of hind tarsi very slightly longer than second. Length, 5-5.5 mm.

♀. Differs in having the antennae and legs somewhat shorter and abdomen not notched.

Hab.—South Australia: Murray River (R. F. Kemp); Victoria: Pianjil, in July (C. Oke); New South Wales: Mulwala (T. G. Sloane). Type, I. 12867.

The sides of the head for their greater extent are quite parallel; the teeth of the mandibles vary on each side, and also on the individuals; those figured are of the type male. The elytra on two specimens are not quite black, although at first glance they appear to be so; their punctures are small and not very sharply defined, but are usually lineate in arrangement. In general appearance like some of the dark forms of *L. mutator*, but head considerably longer and more parallel-sided, eyes smaller, antennae thinner, and not infuscated in middle, etc.

Lathrobium punctipenne, n. sp.

♂. Shining black; tarsi and palpi flavous, a few erect setae on upper-surface, becoming longer and more numerous at apex of abdomen, elytra and abdomen sparsely pubescent.

Head subquadrate between antennae and neck, angles rounded off; with numerous, but not crowded, sharply-defined punctures of moderate size Mandibles strong, with several acute teeth. Antennae with first joint as long as second and third combined, third slightly longer than second and distinctly longer than fourth, fifth-tenth subglobular. Prothorax slightly longer than wide, widest at apex, where the width is about equal to that of head, sides feebly decreasing to base, hind angles strongly rounded; an almost regular row of punctures on each side of the shining median line, towards sides with irregular ones. Elytra about one-fourth wider than prothorax and one-half longer, parallel sided except that the angles are rounded off; with distinct rows of punctures Subapical segment of abdomen triangularly notched at middle of apex on under-surface, the preceding segment depressed there. Front tarsi with four basal joints dilated to form a circular pad, basal joint of hind tarsi slightly longer than second. Length, 4.75-5 mm.

♀. Differs in having the head slightly smaller, the legs slightly shorter, and the abdomen not notched.

Hab.—Western Australia: Swan and Vasse Rivers (A. M. Lea)

A highly-polished black species, like very small and thin *P. australicum*. On the type male the antennae and legs (except tarsi) are almost as dark as the other parts, but on the female they are of a dingy brown. The punctures on the elytra are about as large as those on the prothorax, but being somewhat rugose they are much less sharply defined.

Lathrobium tropicum, n. sp.

♂. Black; legs and part of under-surface of abdomen of a dingy testaceous-brown, antennae darker, but becoming paler towards apex, labial palpi still paler, Length, 5 mm.

Hab.—Northern Territory: Oenpelli (P. Cahill). Type (unique), in National Museum.

The sculpture is almost exactly as described in the preceding species, and the general appearance is much the same, but it differs in having larger eyes (the distance from each eye to the neck is but little more than the length of an eye, on that species it is twice the length of an eye), antennae distinctly longer and thinner, punctures on top of head sparser, prothorax slightly wider, legs paler, and clothing somewhat sparser. From *L. orthodoxum* it differs in having

larger eyes, antennae longer and thinner, and in the prothoracic punctures; on that species the punctures on the sides are irregular up to those on each side of the median line; on the present species (and to a less extent on *L. punctipenne)* the punctures on the sides are also irregular but not up to the median line, so that from certain directions there appear to be three shining lines separated by rows of punctures.

Lathrobium angustulum, n. sp.

♀. Of a dingy piceous-brown; head almost black, antennae, palpi, and legs flavous. With fairly numerous dark setae, the abdomen rather densely pubescent, the elytra more sparsely so.

Head rather elongate; with numerous sharply-defined but not very large punctures, becoming crowded on hind angles. Mandibles strong, each with a large median tooth, and some smaller ones towards base. Antennae with first joint as long as second and third combined, third distinctly longer than second, and almost as long as fourth and fifth combined, the following ones to tenth gradually becoming subglobular. Prothorax distinctly longer than wide, apex slightly narrower than head and not much wider than base, sides gently incurved to middle; with rather dense sharply-defined punctures, but leaving a rather narrow, shining, median line. Elytra distinctly longer than prothorax and slightly wider than its widest part, parallel-sided; punctures somewhat smaller and less sharply defined than those on prothorax. Front femora stout, with a small but acute tooth; front tibiae rather stout, feebly notched near middle; four basal joints of front tarsi dilated to form a suboval pad; basal joints of hind tarsi short. Length, 6 mm.

Hab.—New South Wales: Tamworth (A. M. Lea). Unique.

An unusually narrow species, allied to *L. adelaidae,* but even thinner, darker, antennae longer, and elytral punctures slightly different. The prothorax is not as dark as the elytra, but is not conspicuously reddish, the two apical segments of abdomen, and the tip of the preceding one, are paler that the other segments. The main portion of the head is slightly longer than wide, but from tip of the extended mandibles to the base of the neck the head is almost twice as long as wide. The elytral punctures are not regularly disposed, but from some directions they appear in places to be feebly seriate in arrangement. The abdomen of the type has most of the segments with the membranous part of each showing, so that it appears to be in alternating pale and dark bands, but the pale ones would be concealed on most specimens.

Lathrobium mediopallidum, n. sp.

♂. Pale castaneous; antennae, palpi, and legs paler, head and most of abdomen infuscated. Abdomen with dense and very short pubescence.

Head subquadrate between mandibles and neck; with numerous sharply defined but not very large punctures. Mandibles stout and strongly dentate. Antennae with basal joint as long as second and third combined, third slightly longer than second and conspicuously longer than fourth. Prothorax distinctly longer than wide, widest in front, where the width is slightly less than that of head, sides gently incurved to middle; punctures as on head, except that they are absent from a narrow, shining median line. Elytra parallel-sided, distinctly wider and much longer than prothorax; and with somewhat smaller and denser punctures. Apparent fifth segment of abdomen depressed in middle of apex on under-surface, the sixth triangularly notched there. Front femora stout and with a rather small tooth; front tibiae slightly notched before middle, apical portion stout; four basal joints of front tarsi dilated to form a suboval pad, basal joints of hind tarsi small. Length, 4.25 mm.

Hab.—Queensland: Stewart River (W. D. Dodd). Type (unique), I. 12865.

Allied to *L. micros*, but, apart from colour, differs in having the head, prothorax, and elytra all with different punctures. The colours are apparently as in *L. limbatum*, but differs from description and from a specimen I have, with some doubt, identified as belonging to that species, in having the median line of the prothorax narrower and shorter than is usual in the genus, elytra with punctures not at all seriate in arrangement, and the apical third not "*fere laevi.*" The abdomen is the only part of the upper-surface that is densely clothed, the head and elytra are sparsely pubescent, and the setae are nowhere numerous.

Lathrobium pulchellum, n. sp.

♀. Shining black; prothorax and tips of elytra bright castaneo-flavous, antennae, palpi, and legs flavous, apical portion of abdomen dull red. Upper-surface with sparse dark setae, abdomen rather densely pubescent.

Head between antennae and neck slightly transverse; with moderately large and sharply-defined punctures, very sparse in middle, but numerous on hind angles. Mandibles stout and strongly dentate. Antennae with first joint almost as long as second to fourth combined, third somewhat thinner than second, and about as long, distinctly longer than fourth, the others to tenth more or less globular. Prothorax subquadrate, angles slightly rounded off; with a somewhat irregular row of distinct punctures on each side of middle, sides with fairly numerous punctures, in places with a lineate arrangement. Elytra almost parallel-sided, slightly wider than prothorax, and about one-half longer; punctures rather small and not very sharply defined, but in more or less distinct rows. Front femora stout and obtusely dentate, four basal joints of front tarsi dilated to form a rather small pad, basal joint of hind tarsi slightly longer than second. Length, 4.5 mm.

Hab.—Northern Queensland (Blackburn's collection). Type (unique), I. 12399.

A pretty little species, the type of which was identified by Blackburn as belonging to *Dolicaon quadraticollis*, and except in size, it agrees well with the description of that species; but on comparison with the type it was seen to be very different. In general appearance the type of that species is like a very wide *Lathrobium bipartitum*, about the same length and colour, but about one-half wider; the present species differs from *bipartitum* in being much smaller, decidedly narrower, elytra flatter, with smaller punctures, less of apex pale, and antennae much thinner. The pale portion of the elytra at the suture scarcely occupies one-sixth of their length, but is triangularly dilated to occupy about one-third of each side. At first glance the prothorax appears to be quite square, but on close examination the apex is seen to be slightly wider than the base. The eighth to tenth joints of antennae are each very slightly longer than wide.

Lathrobium transversiceps, n. sp.

♀. Shining reddish-castaneous; legs (except knees, which are slightly infuscated) and palpi paler, most of head deeply infuscated, abdomen slightly infuscated, almost the whole of the three apical segments and the tips of the others paler. With rather short and not very dense setae, the abdomen with very short ashen pubescence.

Head between antennae and neck rather strongly transverse; with fairly large sharply-defined punctures, rather sparse, but becoming crowded on hind angles. Mandibles stout and acutely dentate. Antennae rather long, basal joint as long as second and third combined, third much longer than second or fourth, the others to tenth subpyriform and slightly decreasing in length, but

none transverse, eleventh longer. Prothorax subquadrate, apex slightly wider than base, sides feebly incurved at middle, hind angles strongly rounded; an irregular subgeminate row of punctures on each side of middle, and fairly numerous ones on sides. Elytra parallel-sided, distinctly longer and wider than prothorax, but scarcely one-fifth longer than wide; with somewhat irregular rows of rather small punctures, becoming smaller and less regular posteriorly. Abdomen with dense and small punctures. Front femora stout and slightly dentate, four basal joints of front tarsi strongly dilated to form a subovate pad, basal joint of hind tarsi slightly longer than second. Length, 8 mm.

Hab.—North-western Australia: Behn River (R. Helms). Unique.

In general appearance like small and narrow *L. ferreum*, but elytral punctures very different; very different in colour from *L. fulvipenne*, and base of head, especially at the angles, opaque and with crowded punctures. It is the size and much the colour of *Dolicaon paricolor*, but the head is darker and hind tarsi different. It is apparently allied to *L. pennatum*, as the whole base of the head, in advance of the neck, at first glance appears to be truncated, on close examination, however, the hind angles are seen to be slightly rounded off, but even the slight rounding is partially obscured by clothing. The description of *pennatum* is but little more than a comparison with the ex-Australian *L. fulvipenne;* there are several English specimens of that species before me, and they are black, with the antennae, palpi, legs, and elytra reddish, the latter on one specimen slightly infuscated at the base; in his second table of the species of *Lathrobium*,[21] Fauvel notes *pennatum* as having the head, prothorax, and abdomen black, the elytra reddish, with the base blackish. The punctures on the prothorax are slightly larger than those on the head, in some parts they appear to form irregular rows in addition to those on each side of the middle, but about the apex, except in the middle, they are all irregular.

Lathrobium abdominale, n. sp. Fig. 19.

♂. Black or blackish; mandibles, antennae, and legs of a dingy reddish-brown, tarsi and palpi paler. Rather densely clothed with short ashen pubescence, and with a few dark hairs scattered about.

Head behind antennae subquadrate, but angles rounded off; with crowded and small but sharply-defined punctures; under-surface shagreened. Mandibles stout. Antennae moderately long, first joint slightly longer than second and third combined, third slightly longer than second, and rather more noticeably longer than fourth, the others to tenth subglobular. Prothorax slightly longer than wide, slightly narrower than head, base almost as wide as apex, sides gently incurved to middle; punctures as on head, but leaving a narrow, shining, median line. Elytra parallel-sided, slightly wider than head and considerably longer than prothorax; punctures slightly smaller and not quite as dense as on prothorax. Under-surface of abdomen with a large excavation common to three segments: a small portion at apex of apparent fourth, occupying the apparent fifth for almost its entire width, and most of the apparent sixth; subapical segment deeply notched. Front femora stout, obtusely dentate; front tibiae stout; four basal joints of front tarsi dilated to form a subcircular pad; middle and hind femora somewhat curved. Length, 5.5-6.5 mm.

♀. Differs in being less robust, antennae and legs shorter, femora thinner, the middle and hind ones scarcely curved, and under-surface of abdomen simple.

Hab.—South Australia: Lucindale (B. A. Feuerheerdt). Type, I. 12648.

Close to *L. cribrum*, but differs in being more shining, elytra differently coloured and with somewhat different punctures; the abdomen of the male is very similar, the excavation varies somewhat in extent and depth, but is always

(21) Fauvel, Ann. Mus. Civ. Gen., 1878, p. 521.

conspicuous. On several specimens the elytra are entirely black, but on most of them a fairly wide sutural space from the base to the apex is obscurely reddish, but the red is much more distinct from some directions than from others. On some specimens the antennae (except the basal joint) are almost black. The teeth of the mandibles vary on each side, and also on each individual, the median tooth varies considerably in length (I broke those of several in forcing out the mandibles for examination). The apical joint of the maxillary palpi is rather short and very thin. The first joint of the hind tarsi, from most directions appears to be slightly shorter than the second, but when its whole extent is visible it is seen to be of the same length. The front tibiae of the male are notched about the middle, and there is a comb with many small teeth there, but the clothing is so dense about it that it is difficult to see even the notch from most directions.

Lathrobium apiciflavum, n. sp.

♂. Black; outer apical angles of elytra, labial palpi, and legs flavous. Abdomen and part of head with very short dense pubescence, the former with long hairs about apex, rest of upper-surface shining and with sparse setae.

Head briefly ovate, hind angles strongly rounded; with crowded and small punctures; neck small. Mandibles stout and strongly dentate. Antennae long, passing base of prothorax, all the joints much longer than wide, first about as long as second and third combined, third slightly longer than second and distinctly longer than fourth. Prothorax slightly longer than wide, sides feebly, the angles strongly, rounded, apex scarcely wider than base; with dense and sharply-defined punctures, except on a narrow, shining, median line. Elytra conspicuously longer and wider than prothorax; with somewhat smaller and denser punctures. Abdomen with very dense and minute punctures, apparent fifth segment with a subtriangular notch at middle of apex on under-surface, and a shallower one towards each side. Front femora stout and acutely dentate; front tibiae thin and ridged near base, notched about middle and stout towards apex; four basal joints of front tarsi dilated to form a subovate pad, basal joint of hind tarsi slightly shorter than second. Length, 5-5.5 mm.

♀. Differs in having somewhat shorter and thinner antennae and legs, slightly smaller head, and abdomen not notched.

Hab.—New South Wales: Windsor (H. J. Carter), Narromine (Dr. E. W. Ferguson). Type, I. 12649.

Readily distinguished from all other Australian species by the pale outer apical angles of elytra; it is nearer *L. cribrum* and *L. abdominale* than to the others. Although there are differences in the antennae, tarsi, prothorax, etc., the figure of *Dibelonetes laticeps*[32] will give a good general idea of this insect. The basal joint of antennae, and one or two of the apical ones, are of a dingy flavous, the others are more or less deeply infuscated; the under-surface is not as dark as the upper. The apical joint of the maxillary palpi is fairly long and very thin (almost setiform), much as it is in many species of *Heterothops*. The punctures on the prothorax are slightly larger than those on the elytra, and much more sharply defined than those on the head.

SUNIOPSIS, Fvl., Cat., p. 271.

POLITUS, Lea. W.A. SINGULARIS, Fvl. W.A.

Suniopsis cribripennis, n. sp.

♀. Shining castaneous; part of abdomen infuscated. Antennae, palpi, and legs flavous, basal half of tibiae and of femora infuscated. Labrum and

(32) Sharp, Biol. Cent. Amer., i., (Part 2), 1886, p. 603.

sides of elytra with a few long hairs, more numerous on sides of abdomen and on anal styles, rest of abdomen moderately clothed.

Head oblong-ovate, with a rather large neck; with large and fairly numerous but irregularly distributed punctures; under-surface highly polished, with a few strong punctures on sides. Mandibles long and sharp, with a strong acute tooth about one-third from base, base with two very minute teeth. Eyes large, invisible from below. Antennae thin, none of the joints transverse. Prothorax distinctly longer than wide, widest near apex, where the width is about equal to that of head, and decidedly more than that of base, sides gently rounded, all angles strongly rounded off; with an irregular row of large punctures on each side of the middle, and more irregular ones on sides, a few minute punctures scattered about. Elytra small, much shorter and slightly narrower than prothorax, base strongly, the sides slightly rounded; with coarse crowded punctures. Abdomen slightly dilated posteriorly, the sixth segment largest of all and slightly wider than head, with dense punctures, becoming smaller posteriorly. Length, 7.5 mm.

Hab.—Victoria: Dividing Range (Blackburn's collection). Type (unique), I. 12622.

The front tarsi are not very thin, and are distinctly shorter and wider than the others. In general appearance the species is close to *Hyperomma pictipes*, but is referred to *Suniopsis* on account of the maxillary palpi, of these the third joint is large, elliptic-ovate, and with the fourth quite concealed in its apex. There are two ball-like appendages to the mentum, but the type being unique I have not dissected out the mentum to examine its paraglossae. The mandibles are almost exactly as in *H. bryophilum*, and practically the only feature generically distinguishing it from that species is the apical joint of the maxillary palpi; the fact that this species has the curious ball-like appendages as in most, if not all, species of *Hyperomma*, would appear to indicate that the two genera should be combined; if this course should be decided upon, *Suniopsis* has page priority.

Suniopsis picticornis, n. sp.

♂. Black and highly polished; mouth parts, two basal joints of maxillary palpi, and mandibles reddish, two basal joints of antennae reddish, the apical one almost flavous, the intervening ones more or less deeply infuscated; femora pale (almost watery) flavous, tibiae and tarsi infuscated. Head, sides of prothorax, and of elytra with long straggling hairs, becoming numerous on sides of abdomen and on anal cerci, rest of abdomen densely clothed.

Head oblong-ovate, with a rather large neck; with large and numerous but irregularly distributed punctures, and a few minute ones; under-surface polished and with scattered punctures. Mentum triangularly notched in middle, each side margining the notch slightly produced. Eyes of moderate size, concealed from below. Mandibles rather long and acute, a small but distinct tooth near base. Antennae rather short, joints after the third feebly decreasing in length, the ninth and tenth scarcely, if at all, longer than wide, eleventh somewhat longer. Prothorax distinctly longer than wide, apex slightly wider than head, and distinctly, but not much, wider than base, sides gently rounded, all angles feebly rounded off; an irregular semidouble row of moderately large punctures on each side of middle and irregular ones on sides, a few minute punctures scattered about. Elytra very small, much shorter than prothorax, and slightly narrower at widest; with fairly dense and rather large punctures. Abdomen almost parallel-sided to near apex, sixth segment largest of all and slightly wider than prothorax; with dense punctures, subapical segment with a deep triangular notch on under-surface, with a fine margining membrane. Legs not very long, front tarsi thin, but somewhat wider and shorter than the others. Length, 8 mm.

Hab.—South Australia: Myponga, in moss (A. H. Elston). Type (unique), I. 12858.

The base and apex of prothorax and tip of abdomen are obscurely diluted with red. From some directions some of the elytral punctures appear to be lineate in arrangement. At first glance the type appears very close to *Hyperomma nigrum*, but the large joint of the maxillary palpi is dark, the fourth joint is apparently missing, and the femora are very pale throughout. Under the microscope the third joint of the maxillary palpi is seen to be large, its tip truncated, with the fourth, on the right side, completely buried in its tip, and the one on the left side with its tip just showing. In manipulating the mouth parts for examination some slight force was used, and this may possibly have pressed out the tip of the fourth joint; quite possibly, however, the fourth may be capable of retraction; if this should be the case it removes the main distinction between *Suniopsis* and *Hyperomma*.

HYPEROMMA, Fvl., Cat., p. 269.

An interesting genus, all the known species of which are apterous, and have a small but distinct apical joint to the maxillary palpi, apparently the only distinguishing feature from *Suniopsis*, in which the true fourth joint is buried within the tip of the third. Fauvel recorded *Hyperomma* as having the front tarsi dilated, and *Suniopsis* as having them thin, but in several species of *Hyperomma* they are no wider than in the known species of *Suniopsis*. The species of both genera, except a doubtful one referred to *Hyperomma*, have eyes on top of the head, so as to be invisible from below. Following is a table of the Australian species:—

A. Body parts, except tip of abdomen, entirely black.
- *a*. Head and prothorax finely shagreened .. .. *globuliferum*
- *aa*. Head and prothorax not shagreened.
  - *b*. Legs variegated .. .. *nigrum*
  - *bb*. Legs entirely red.
    - *c*. Front tarsi strongly dilated .. .. *labrale*
    - *cc*. Front tarsi rather thin.
      - *d*. Prothorax conspicuously dilated to near apex .. .. .. *cribratum*
      - *dd*. Prothorax scarcely wider near apex than near base .. .. *cylindricum*

AA. Body parts only partly, or not at all, black
- B. Eyes minute and lateral .. .. *microps*
- BB. Eyes large and on top of head.
  - C. Head and prothorax finely shagreened .. .. *megacephalum*
  - CC. Head and prothorax not shagreened.
    - D. Length less than 5 mm. .. .. *inquilinum*
    - DD. Length more than 6 mm.
      - E. Legs variegated .. .. *pictipes*
      - EE. Legs not variegated.
        - F. Upper-surface of head obliquely and longitudinally strigose *abnorme*
        - FF. Upper-surface of head not strigose.
          - G. Prothorax and elytra uniformly coloured .. .. .. *lacertinum*
          - GG. Prothorax and elytra not uniformly coloured .. .. *bryophilum*

ABNORME, Blackb.	V., Tas.	NIGRUM, Lea.	W.A.
LACERTINUM, Fvl.	S.A., W.A.	PICTIPES, Lea.	Tas.

HYPEROMMA LACERTINUM, Fvl.

A female, from St. Francis Island (South Australia), probably belongs to this species, but differs from the description in being smaller, 11 mm.; the type was also described as "obscure rubrum, abdomine piceo"; the island specimen is of a rather bright reddish-castaneous, with the abdomen blackish, except that the apical segment and the tips of the others are obscurely reddish.

Hyperomma abnorme, Blackb.

A specimen, from Tasmania, probably belongs to this species, but differs from a cotype in having the row of punctures on each side of the middle of the prothorax semidouble, and the head nonstriated (this, however, was noted as a sexual feature); in general appearance it is very close to the preceding species, but the head, prothorax, elytra, and abdomen are of an almost uniform shade of colour throughout, and the elytral punctures sparser and less sharply defined, although decidedly larger.

Hyperomma globuliferum, n. sp. Figs. 20 and 31.

♂. Black; mouth parts, antennae (most of the joints partly infuscated), palpi and legs reddish, anal styles darker. Head, sides of prothorax, and of elytra with straggling dark hairs, becoming numerous on sides of abdomen posteriorly, rest of abdomen (both surfaces) with short and dense setae.

Head subquadrate; with rather dense and small, but fairly sharp punctures, and with much larger ones irregularly scattered, but four between bases of antennae; under-surface transversely strigose, but at sides shagreened, a few strong punctures scattered about. Mandibles long, thin, and simple, except for the swelling at inner base. Antennae thin, third joint about one-third shorter than first, about one-third longer than fourth, and twice the length of second. Maxillary palpi with third joint long, the fourth short and briefly conical. Prothorax distinctly longer than wide, widest near apex, where it is as wide as base of head and about one-third wider than its own base, all angles rounded off; with an irregular row of distinct punctures on each side of middle and with minute ones scattered about; towards each side with another irregular row of punctures, then punctures about as large as the small ones on head, mixed with a few other larger ones; front of prosternum strongly transversely strigose. Elytra very short, scarcely more than half the length of prothorax, slightly dilated to apex, where the width is less than that of prothorax; with crowded and rather coarse punctures, with a few somewhat larger ones scattered about, an irregular depression near each side. Abdomen almost parallel-sided to near apex; with crowded punctures; under-surface of sixth segment with a deep notch, margined by a thin membrane. Front tarsi with basal joints feebly dilated. Length, 12-16 mm.

♀. Differs in having the head somewhat wider, abdomen more dilated posteriorly, and the sixth segment not notched.

Hab.—Victoria: Dandenong Ranges (Blackburn's collection), Emerald (H. H. D. Griffith from E. Jarvis), Mount Macedon (H. W. Davey), Gippsland (Dr. E. W. Ferguson), Belgrave in January, October, November (F. E. Wilson), and in February (C. Oke), Ferntree Gully in July (Oke); New South Wales: Nowra (Ferguson). Type, I. 12401.

About the size and colour of *Dicax cephalotes* and *Scymbalium duplopunctatum*, but apterous, mandibles simple, etc. The head and prothorax are very finely shagreened, and although hardly opaque are less shining than the elytra; the eyes are large and invisible from below. The hairs about the mouth are longer and paler than those on the other parts of the head. The punctures in the prothoracic rows vary in number from twelve to eighteen, they are slightly smaller than the large ones on head, and the minute ones are also smaller than those on head, except at the sides, where they are about as large.

This species has two curious processes attached to the mentum; they appear like two pale almost circular balls, they are of fairly large size and quite distinct from below, or from in front, when the mandibles are open; although from most directions they appear to be globular, from an oblique direction each is seen to have a small circular concavity. Under a compound power they are seen to

be separated by the median projection of the mentum and to be inwards of the paraglossae (on this species the paraglossae are large, comb-shaped, with numerous long close-set teeth), the basal half of the basal joint of the palpi appears as if squeezed thin by them. They are not sexual, and are present, but smaller, on other species of the genus. On first seeing them I was under the impression that they were beetle mites in an unusual position.

Two badly-damaged males from Kangaroo Island (J. G. O. Tepper) apparently belong to this species, but differ from the types in being smaller and thinner, head somewhat longer, and its under-surface, as also that of the prosternum, less conspicuously transversely strigose.

Hyperomma megacephalum, n. sp.

♀ Dull castaneous, some parts slightly darker than others; antennae, palpi, and legs paler (castaneo-flavous). Head, sides of prothorax and of elytra with sparse straggling hairs, becoming denser on abdomen, especially about apex, both surfaces of abdomen with dense, short, depressed clothing.

Head subquadrate; with numerous small punctures and with larger ones scattered about and becoming crowded on sides; under-surface transversely strigose. Eyes large and invisible from below. Mandibles long and thin. Antennae thin, third joint one-third shorter than first, one-third longer than fourth, and twice the length of second. Subapical joint of maxillary palpi large, the apical one small and briefly conical. Prothorax longer than wide, apex scarcely as wide as head, obliquely narrowed to base, all angles rounded off; with minute punctures becoming larger on sides, on each side of middle with an irregular row of large punctures, each side with two still more irregular rows, becoming conjoined at base and apex. Elytra slightly shorter than head and much shorter than prothorax, slightly dilated to apex, where the width is about equal to that of the middle of the prothorax; with rather large crowded punctures. Abdomen dilated to near apex, fifth segment largest of all and slightly wider than head. Basal joints of front tarsi feebly dilated. Length, 12.5 mm.

Hab.—Victoria: Dandenong Ranges (C. French). Unique.

The head with the mandibles clenched is (except for the neck and for the rounding off of the angles) an almost perfect square; the mandibles have not been forced open, but they appear to be simple. The head and prothorax are very finely shagreened, and in consequence less shining than the elytra; there are seven large punctures on the front of the clypeus, but they are irregularly placed, of the rows of punctures on each side of the middle of the prothorax there are 17 in one, and 19 in the other; on each elytron there are three irregular rows of punctures, larger than the others, but they are not very distinct at the first glance. The head is larger and abdomen more dilated posteriorly than in any other known species of the genus; the curious ball-like appendages to the mentum are quite as distinct as on *H. globuliferum*.

Hyperomma cylindricum, n. sp. Fig. 21.

♂. Black; mouth parts, antennae (most of the joints partly infuscated), palpi, legs, and tip of abdomen red. Head, sides of prothorax, and of elytra with long straggling hairs, becoming numerous on abdomen, especially at apex; abdomen, both surfaces, with rather dense depressed clothing.

Head oblong-elliptic; with dense and small sharply-defined punctures, with many larger ones scattered about, a rather narrow, shining, and almost impunctate space between eyes; under-surface strongly shagreened, becoming longitudinally striated near base; with large punctures scattered about, but an almost impunctate, narrow, shining, median triangle. Mandibles long, thin, and, except for the inner enlargement at base simple. Antennae rather long and

thin, none of the joints transverse. Subapical joint of maxillary palpi large, the apical one small and briefly conical. Prothorax oblong-elliptic, almost twice as long as wide, base not much wider than apex, all angles rounded off; with fairly numerous minute but sharply-defined punctures, becoming slightly larger on sides; each side of middle with an irregular, in parts semidouble row of large punctures, the sides also with large punctures, front portion of prosternum evenly transversely strigose. Elytra about the length of head (excluding mandibles) and much shorter than prothorax; with dense and rather coarse punctures, and with irregular rows of larger ones. Abdomen slightly dilated to near apex, sixth segment largest of all; with dense punctures becoming sparser about apex; under-surface of subapical segment with a deep triangular notch, margined by a thin membrane. Front tarsi thin. Length, 10.5-14 mm.

♀. Differs in having the abdomen somewhat wider with the subapical segment not notched.

Hab.—New South Wales: Sydney (Dr. E. W. Ferguson and A. M. Lea), Mount Kosciusko (H. J. Carter), Blue Mountains (Ferguson); Victoria: Warburton in April (F. E. Wilson), Mount Macedon (H. W. Davey), Bellgrave in January and Ferntree Gully in July (C. Oke), Alps, No. 1633 (Ejnar Fischer), Emerald (H. H. D. Griffith from E. Jarvis). Type, I. 15233.

A long species almost cylindrical throughout, except for short indentations, the greatest width of the head, prothorax, and elytra are practically equal, and very little less than the greatest width of the abdomen. The tips of the antennae are almost flavous, the tip of the sixth segment, the whole of the seventh, and the anal styles are conspicuously reddish on some specimens, but feebly so on others. The upper-surface of the head, and the prothorax, are not at all shagreened, consequently they are as highly polished as the elytra. The eyes are large, but do not alter the curvature of the sides, and are invisible from below; the inner enlargement at the base of each mandible has a feeble projection, but it is quite invisible unless the mandibles are widely open, and even then it is invisible from some directions. The species differs from *H. globuliferum* in the thinner and more cylindrical body, longer head with different sculpture on both surfaces, base of mandibles, prothorax scarcely wider at apex than base, no part of upper-surface shagreened, etc., there are globular appendages to the mentum, but they are smaller than on that species. In general appearance it strongly resembles *Scymbalium duplopunctatum*, but the antennae, palpi, mentum, punctures, and apterous body are all different. The front tarsi are thin, as in *Suniopsis*, but as the maxillary palpi are exactly as on several species of *Hyperomma*, it was referred to the latter genus. There is a specimen of the species in the Australian Museum (K. 21093, from Mount Kosciusko).

Hyperomma labrale, n. sp. Fig. 22.

♀. Black; mouth parts, antennae (most of the joints infuscated), palpi, legs, and tip of abdomen red.

Head subquadrate; with fairly numerous, small, but sharply-defined punctures, and some large ones irregularly scattered; under-surface opaque and finely shagreened; with large scattered punctures, smooth and shining between the gular sutures, and striated about base. Mandibles long, apical half thin, then dilated with a blade-like edge to near base, which is finely dentate. Antennae thin, none of the joints transverse. Maxillary palpi with subapical joint long, the apical one small and briefly conical. Prothorax slightly longer than wide, scarcely wider than head, very feebly diminishing in width to base, all angles rounded off; with rather sparse and minute but sharply-defined punctures, becoming larger and denser on sides, each side of middle with an irregular row (thirteen on one side, seventeen on the other) of large punctures, the sides

also with numerous large ones; front of prosternum transversely strigose. Elytra slightly narrower than prothorax and much shorter. Abdomen somewhat dilated posteriorly; with crowded punctures and finely shagreened. Femora stout, front ones stouter than the others and feebly dentate; four basal joints of front tarsi strongly dilated. Length, 12 mm.

Hab.—New South Wales: Illawarra (H. J. Carter). Type (unique), I. 12601.

The head, except for some long hairs about the muzzle, prothorax, and elytra are very sparsely clothed, but this may be due to abrasion. The shape of the mandibles and strongly dilated front tarsi are sufficient to distinguish the species from all other black-bodied ones of the genus. The labrum is also peculiar, owing to its punctures being unusually large its front appears multi-sinuate, instead of evenly bilobed. A second female (received by Mr. Griffith from Mr. Carter) has damaged antennae, but is otherwise perfect, and it has two ball-like appendages in the mouth as in *H. globuliferum*.

Hyperomma cribratum, n. sp.

♀. Black and highly polished, mouth parts, antennae (most of the joints deeply infuscated except at base), palpi and legs red, tip of abdomen obscurely reddish. Head with a few straggling black hairs, still fewer on sides of prothorax and elytra, abdomen densely clothed, the sides and tip with long hairs.

Head (excluding neck) slightly wider than long, base slightly wider than elsewhere; with dense and rather small sharply-defined punctures, and large ones scattered about; under-surface strongly transversely strigose, and with large scattered punctures, gular sutures forming the sides of a smooth triangle from mentum to middle, but single from there to neck. Labrum larger than usual and deeply notched. Eyes large, invisible from below. Mandibles long, thin, and simple, except for a minute tooth at inner base. Antennae thin, none of the joints transverse. Subapical joint of maxillary palpi large, the apical one small and briefly conical. Prothorax distinctly longer than wide, widest near apex, where the width is slightly more than that of head, sides obliquely decreasing to base, all angles rounded off; with rather dense and small but sharply-defined punctures, becoming denser and larger on sides, each side of middle with an irregular (semidouble) row of large punctures, the sides also with large ones. Elytra small, shorter than head, much shorter than prothorax, and not much wider than its base, almost parallel-sided; with fairly coarse crowded punctures, and irregular rows of larger ones. Abdomen feebly dilated posteriorly, with crowded punctures. Front femora stout and rather obtusely dentate; front tarsi thin. Length, 16 mm.

Hab.—Western Australia: Swan River (J. Clark). Type (unique), I. 15231

The head is decidedly shorter than in *H. cylindricum*, the sculpture of its under-surface is very different, the mandibles are longer, although much the same at base, the prothorax is conspicuously dilated in front and its punctures are much more conspicuous. The shape of the prothorax is much as in *H. globuliferum*, but it is not shagreened, and its punctures are denser and more conspicuous than on that species; the globular appendages to the mentum are smaller and less conspicuous.

Hyperomma bryophilum, n. sp. Fig. 23.

♂. Bright castaneous; middle of head and of prothorax, elytra, sixth segment of abdomen, and base of some of the others more or less conspicuously infuscated, mouth parts, antennae (some of the median joints infuscated), palpi, and legs castaneo-flavous. Head, sides of prothorax and of elytra, sides and

tip of abdomen with long and rather sparse hairs, rest of abdomen with (for the genus) rather sparse clothing.

Head oblong-ovate; with large scattered punctures and a few minute ones; under-surface with a few scattered punctures. Labrum large, deeply notched in middle, concealing most of mandibles when clenched. Eyes large, invisible from below. Mandibles long and acute, with an acute tooth near middle and two minute ones at base. Antennae thin, none of the joints transverse, first as long as second and third combined, third very little longer than fourth. Subapical joint of maxillary palpi large, the apical one small and briefly conical. Prothorax distinctly longer than wide, widest near apex, thence obliquely diminishing in width to near base, all angles rounded off; with an irregular row of large punctures on each side of middle, and some large ones on sides, a few minute punctures scattered about. Elytra small, shorter than head, and much shorter than prothorax, base rounded, sides slightly dilated posteriorly; with large and fairly dense punctures. Abdomen large, slightly dilated posteriorly, sixth segment largest of all, under-surface of seventh deeply notched, anal styles long; with numerous but not crowded punctures. Femora rather stout, four basal joints of front tarsi rather strongly inflated. Length, 7.5-8.5 mm.

♀. Differs in having the head somewhat smaller, abdomen not notched, and front tarsi less strongly (although noticeably) inflated.

Hab.—Tasmania: Waratah, in moss (A. M. Lea).

The infuscated parts of the head and prothorax are almost circular, they are very distinct on some specimens, but scarcely traceable on others; from three to five of the apical joints of antennae are flavous. The fairly wide front tarsi and distinct fourth joint of maxillary palpi would seem to refer the species to *Hyperomma*, but the mandibles are armed, as in *Suniopsis*. It is allied to *H. pictipes*, from which it differs in being paler, with the legs uniformly coloured (there are five specimens of the present species before me, and two of *pictipes).* I have not dissected out the mentum, but there appear to be two small globular processes at its apex.

Hyperomma inquilinum, n. sp.

♂. Pale castaneous; elytra and most of abdomen infuscated; mouth parts, two basal joints of antennae (the others missing), palpi, and legs flavous. Upper-surface with sparse hairs at sides, the abdomen moderately densely clothed.

Head oblong-ovate; with fairly large scattered punctures, and some minute ones; under-surface shining and with scattered punctures. Labrum deeply notched in middle. Mandibles long, thin, curved, and simple. Eyes rather large, invisible from below. Subapical joint of maxillary palpi large and stout, the apical one small and briefly conical. Prothorax distinctly longer than wide, widest near apex, where the width is slightly more than that of head, sides gently rounded and decreasing to base; a row of large punctures on each side of middle, and others on sides, minute ones scattered about. Elytra small, about two-thirds the length of prothorax and decidedly narrower, base strongly rounded, the sides moderately so; each with four irregular rows of large punctures. Abdomen about half the total length, sides feebly increasing in width to sixth segment, which is the largest of all; with fairly dense punctures, except at tips of segments; under-surface of seventh segment with an equilaterally triangular notch at apex. Femora stout, front tarsi moderately wide. Length, 3.5 mm.

Hab.—Western Australia: Swan River, from a nest of *Iridomyrmex conifer* (J. Clark). Type (unique), I. 12626.

The smallest known species of the genus, but apterous and with quite typical mandibles, eyes, and palpi; the front of the mentum is obscured on the

type. The pale parts of the abdomen are the seventh segment, apical half and sides of the sixth, and sides and tips of the others.

A male, from Victoria (Blackburn's collection), evidently belongs to the species, but differs from the type in being larger, 4.75 mm., with less of the sixth and seventh segments of abdomen pale, and more of the others; the antennae are perfect, their median joints are slightly infuscated and apical ones flavous, the fourth to tenth are each about as long as wide or very slightly transverse, and the eleventh is longer.

Hyperomma microps, n. sp.

♀. Pale castaneous; antennae, palpi, and legs still paler. Sides with a few straggling hairs, abdomen rather sparsely clothed.

Head subovate, with a large neck; with fairly dense and large punctures; under-surface with a few scattered ones. Eyes minute and lateral Mandibles long, with a strong compound tooth, about one-third from base but normally concealed. Antennae short, fourth to ninth joints slightly transverse, tenth about as long as wide, eleventh slightly longer. Maxillary palpi with subapical joint large and swollen, apical one small and briefly conical. Prothorax much longer than wide, apex scarcely wider than base and narrower than head, all angles rounded off; with an irregular row of rather large punctures on each side of middle, and two still more irregular rows on each side, minute punctures scattered about. Elytra very small, much shorter than prothorax, and at apex about as wide, but feebly decreasing in width to base; with rather sparse and rather large punctures, a few forming an irregular row on each side of suture. Abdomen gently increasing in width posteriorly, sixth segment largest of all and distinctly wider than head; with fairly numerous punctures. Legs rather short, front tarsi simple. Length, 4 mm.

Hab.—Tasmania: Waratah, in moss (A. M. Lea). Unique.

An anomalous species, for which probably a new genus should have been proposed. The minute eyes, strictly lateral and consequently visible both from above and below, are distinctive from all known species of *Hyperomma* and *Suniopsis*, and the antennae with most of the joints transverse are also aberrant; the front tarsi are simple as in *Suniopsis*, but the apical joint of the maxillary palpi is distinct; the mandibles are dentate, but they vary in *Hyperomma*. It should possibly have been referred to *Scimbalium*, but as I know no apterous species of that genus, and as in most generic details it agrees with *Hyperomma*, it has been referred to the latter. In size it is only larger than *H. inquilinum*.

Macrodicax, n. gen.

Head large, with a wide neck. Eyes small, latero-frontal. Labrum transverse, sides pointed. Mandibles long and powerful, strongly tridentate. Mentum with two globular processes in front; labial palpi small and thin. Maxillary palpi with subapical joint large, shorter than preceding joint, and about twice the length of the apical one, which is conical. Antennae thin but not very long. Prothorax large, somewhat dilated in front. Scutellum strongly transverse. Elytra small. Abdomen rather short and wide, five segments strongly margined, anal styles moderately long. Femora rather stout, edentate; hind tibiae rather long, the others shorter; front tarsi with four basal joints dilated to form a conspicuous pad, the fifth rather long and thin; basal joint of each of the other tarsi distinctly longer than the second, the others evenly decreasing in length to fourth, fifth as on front tarsi. Body apterous.

A remarkable genus with two ball-like objects in the mouth, as in *Hyperomma* (they are visible from directly in front and very distinct from

below), but from that genus it differs in the strongly dentate jaws, labrum incurved to middle instead of deeply notched, eyes smaller, lateral and with somewhat larger facets, and front tarsi strongly dilated. The jaws, eyes, labrum, mandibles, and tarsi are all different from those of *Suniopsis*. The head is somewhat like that of *Dicax* (all the known species of which are winged), but the middle and hind tarsi are very different, somewhat resembling those of *Scimbalium*, whose front tarsi, however, are usually thinner. In catalogues the genus should be placed near *Dicax* and *Hyperomma*.

Macrodicax potens, n. sp. Fig. 2.

♂. Black, in parts with a slight bronzy gloss; mouth parts, parts of mandibles, antennae, palpi, legs, most of sterna, and a narrow strip (between the gular sutures) on under-surface of head more or less reddish, parts of under-surface of abdomen obscurely diluted with red. Upper-surface with rather long, scattered, dark hairs, becoming dense on abdomen and legs, front of labrum with long reddish hairs.

Head subquadrate between front and neck, hind angles rounded off, front feebly incurved to middle; with fairly numerous, large, setiferous punctures, but absent from a space along middle; with numerous minute punctures scattered about. Antennae thin but not very long, none of the joints transverse, first stouter than the others, and almost as long as second to fourth combined, fourth somewhat longer than second and much shorter than third. Prothorax slightly longer than wide, apex slightly wider than base, and slightly curved near each side, sides gently incurved near base; with a semidouble row of distinct punctures on each side of middle, more irregular ones towards and on sides, and with numerous very minute ones scattered about. Elytra conjointly transverse, distinctly shorter than prothorax and less than its greatest width; with irregular rows of large rough punctures, some of which are irregularly longitudinally confluent. Upper-surface of abdomen with rather dense and not very deep but sharply-defined punctures; under-surface with somewhat similar ones, but becoming suddenly much smaller and denser in middle of second and third segments, sixth segment deeply notched in middle. Front tibiae notched on inner side towards base. Length (excluding mandibles), 14 mm.

Hab.—New South Wales: Dorrigo (H. W. Cox). Unique.

A powerful-looking insect, with a bigger head than any other apterous species of the family known to me from Australia. In some lights parts of the abdomen appear to be slightly iridescent. There appears to be at least one comb of small golden teeth at the notch on each front tibia, but I have been unable to see it clearly, partly owing to the density of the clothing; the notch itself is distinct from but few directions; the tip of each tibia has a fringe of golden setae on its upper edge, less distinct on the middle ones than on the others. The left mandible is slightly dilated from the tip to beyond the middle, when its inner edge slightly curves inwards before a strong acutely-triangular tooth, beyond this are two smaller but fairly large teeth; the right mandible is without the slight incurvature before the big tooth, and its two smaller teeth are smaller than those on the left, and should perhaps be regarded as cusps of a tooth. The antennae are now broken on the type, only four joints remaining on one of them, but one was perfect when the figure was drawn. The head and prothorax are very finely shagreened, the elytra rather more coarsely. The large punctures on the head are smaller than those on the elytra, but more sharply defined and evenly rounded, they are considerably larger than those on the prothorax, the minute ones on the latter, except in certain lights, are scarcely distinguishable from the shagreening.

DICAX, Fvl., Cat., p. 276.

ARCULUS, Fvl. V.
CEPHALOTES, Fvl. W.A.
 ventralis, Lea.
DESERTI, Blackb. N.S.W., S.A., W.A., N.T., C.A.
LONGICEPS, Fvl. (*Lathrobium*). N.S.W.
RUBRIPENNIS, Fvl. V.
RUFICOLLIS, Lea. Q., N.S.W.
 var. *nigriventris*, Lea.

DICAX CEPHALOTES, Fvl.

D. ventralis, Lea.

The tip of the subapical segment of the abdomen of the male of this species has two comb-like processes,[23] and largely because these were not mentioned by Fauvel in his description of the abdomen of the male *D. cephalotes*,, I presumed that *D. ventralis* was not that species. On examining some greasy specimens recently, however, the combs were scarcely visible, and so they might easily have been overlooked by Fauvel; it would appear, therefore, that the names are synonymous.[24]

DICAX LONGICEPS, Fvl.

A specimen from Ebor (New South Wales) in the Queensland Museum probably belongs to this species, but differs from the description in being smaller —7.5 as against 9.5 mm.

DICAX DESERTI, Blackb.

Blackburn's description of the colour of *D. deserti* is practically identical with that of Fauvel's *D. rubripennis*, except that the latter did not mention the tip of the abdomen as partly red; its legs vary from a dingy piceous-brown with the tarsi and front coxae paler, to deep black, with the tarsi and metasternum of a dingy brown, the elytra vary from rather dark red to bright castaneous. Two specimens, from Oodnadatta, are labelled as cotypes, although in the description only Storm Creek was mentioned.

Var. Four specimens, from Mulwala, appear to belong to the species, they differ from the typical form in being smaller, 6.5-7 mm., the legs deep black, except that the tarsi are obscurely brown, and the metasternum blackish. Their colours, in fact, are exactly as on some of the larger ones, but I have seen no specimens intermediate in length between 7.5 and 10.5 mm.

DICAX RUBRIPENNIS, Fvl.

A cotype of this species (from the British Museum) differs from small specimens of *D. deserti* in having the abdomen entirely black, the head, prothorax, and elytra with a faint pruinose gloss (not mentioned by Fauvel) and the punctures somewhat smaller and sparser.

SCIMBALIUM, Er., Cat., p. 270.
(Frequently written *Scymbalium*.)

AGRESTE, Blackb. V., S.A., C.A.
ARCUATUM, Fvl. N.S.W., V., Tas., S.A., N.W.A.
AUSTRALE, Fvl. Q., N.S.W., C.A.
DUPLOPUNCTATUM, Fvl. V., S.A., C.A.
LAETUM, Blackb. S.A.
MICROCEPHALUM, Fvl. (*Cryptobium*), Cat., p. 284. Q., N.S.W., V., Tas., S.A.
OPACULUM, Fvl. Q., N W.A.
PICEUM, Macl. (*Lathrobium*), Cat., p. 265. Q., N.W.A.
 ferrugineum, Fvl.
RUFUM, Fvl. V., S.A.
SIMPLARIUM, Fvl. N.S.W., V., Tas., S.A., N.W.A.
SPARSICOLLE, Fvl. Q., N.S.W., V., S.A.

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(23) Lea, Proc. Linn. Soc. N.S. Wales, 1904, pl. 4, fig. 12.
(24) Since this was written I have received a cotype of *cephalotes* from the British Museum, which puts it beyond question.

SCIMBALIUM PICEUM, Macl.

S. ferrugineum, Fvl.

A specimen, from Northern Queensland, identified by Blackburn as *S. ferrugineum*, and agreeing with the description, was compared and agrees with the type of *Lathrobium piceum*. As its front tarsi are only moderately dilated and basal joint of hind tarsi distinctly longer than the second, it is quite evidently a *Scimbalium*.

SCIMBALIUM RUFUM, Fvl.

Two specimens of an apterous species, from Melbourne, agree well with the description of this species; at first glance they are strikingly like *Lathrobium adelaidae*, but the antennae are longer, elytra distinctly shorter, front tarsi less dilated, and basal joint of hind tarsi as long as the two following combined.

Scimbalium pallidulum, n. sp.

Pale castaneous; antennae, palpi, and legs paler, head slightly infuscated. With fairly numerous dark hairs scattered about; abdomen with rather dense ashen pubescence, head and elytra more sparsely clothed, prothorax with hairs but hardly any pubescence.

Head between antennae and neck about as long as wide; with numerous, fairly large, sharply-defined punctures, becoming smaller and more crowded in hind angles (which are strongly rounded). Antennae thin, passing base of prothorax, first joint almost as long as second and third combined, third distinctly longer than second and fourth, the others to tenth gradually decreasing in length, but all distinctly longer than wide. Prothorax distinctly longer than wide, almost parallel-sided, except that the angles are rounded; with rather dense punctures, smaller than on head, but absent from a rather narrow median line. Elytra distinctly longer and wider than prothorax, sides slightly dilated posteriorly; with rather dense and asperate but sharply-defined punctures, nowhere seriate in arrangement. Legs rather long; front femora slightly dentate; front tibiae notched at about basal third; front tarsi with four basal joints almost as wide as apex of tibiae, the other tarsi longer and thinner. Length, 6-7 mm.

Hab.—Northern Territory: Daly River (H. Wesselman), Adelaide River (British Museum); North-western Australia: Derby (W. D. Dodd and Dr. A. M. Morgan). Type, I. 12645.

In appearance close to *S. semifumatum*, but head and abdomen paler, antennae and prothorax longer, and elytral punctures somewhat different. The colour and size would do fairly well for *S. opaculum*, but punctures of head and prothorax certainly differ from the description; in Fauvel's table[35] the prothorax and elytra are noted as having very dense obsolete punctures; on the present species the elytral punctures are dense and rather small, although quite distinct, on the prothorax they are sparser, somewhat larger, and quite sharply defined, but absent from a median line. The prothorax is of a brighter colour than the rest of the upper-surface. The mandibles are stout and strongly dentate, the front tooth larger than the others. The tip of the abdomen is triangularly notched in the male, and the front femora are rather more strongly dentate than in the female.

Scimbalium micropterum, n. sp.

♀. Black; prothorax and legs dark red, palpi and tarsi paler, parts of antennae reddish, but mostly deeply infuscated. With fairly numerous dark hairs, elytra and abdomen with dark pubescence, rather dense on the latter.

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(35) Fauvel, Ann. Mus. Civ. Gen., 1878, p. 526.

Head subovate, hind angles strongly rounded; with irregularly distributed and fairly large sharply-defined punctures, absent from a small median space. Mandibles rather long and strongly dentate. Antennae thin, passing base of prothorax, first joint as long as second and third combined, fourth slightly longer than second, and distinctly shorter than third and fifth, the others to tenth gradually decreasing in length, but all distinctly longer than wide. Prothorax distinctly longer than wide, all angles rounded, apex slightly wider than base, sides with a very feeble incurvature near base; punctures sharply defined but smaller than on head, not very dense, and absent along middle. Elytra about one-fourth wider than prothorax, and slightly longer; each with five somewhat irregular rows of moderate punctures on disc, becoming irregular posteriorly, a few on sides. Abdomen with punctures (both surfaces) smaller, denser, and more asperate than on apical parts of elytra. Front femora rather stout and moderately dentate; front tibiae notched near basal third; front tarsi with four basal joints slightly wider than apex of tibiae, the other tarsi longer and thinner, with the basal joint as long as the three following combined. Length (excluding mandibles), 9 mm.

Hab.—Western Australia: Mount Barker (A. M. Lea). Unique.

In general appearance somewhat like *S. laetum* and *S. arcuatum*, but with darker elytra and paler prothorax, the punctures are also much sparser on the prothorax and elytra. The elytra are smaller than is usual on winged species of the genus, but I have made sure that wings are present. I have not dissected out the mentum of the type, but it has two globular appendages at the apex, apparently as in species of *Hypcromma.* On the type the abdomen is unduly extended, with the membranous parts of five segments showing conspicuously pale. The head and prothorax are highly polished, the elytra rather less so. The punctures on each side of the median line of the prothorax are irregularly lineate in arrangement.

DOLICAON, Cast., Cat., p. 274.

MASTERSI, Macl. *(Pinobius).* Q.
NIGRIPENNIS, Macl. Q., N.S.W., N.W.A.
PARICOLOR, Fvl. Q, N.T.
QUADRATICOLLIS, Macl. Q.

Dolicaon alatus, n. sp. Figs. 24-26.

♂. Bright castaneous-red; two apical segments of abdomen, femora, and tibiae black, four to six basal joints of antennae infuscated or black, the others pale. Upper-surface moderately clothed with ashen pubescence, the head and prothorax more sparsely than elsewhere.

Head, excluding mandibles and neck, distinctly transverse; with fairly large and numerous but not crowded punctures, and with minute ones scattered about. Antennae extending to base of prothorax, first joint curved, as long as second and third combined, third almost twice as long as second and fourth, seventh to tenth subglobular, becoming feebly transverse. Mandibles stout and strongly dentate. Prothorax at apex almost as wide as the median length, but base narrower, all angles moderately rounded off; punctures much as on head, but absent from a rather narrow median line. Elytra slightly wider than widest part of prothorax and not much longer, angles rounded off, sides almost parallel; with rather dense and sharply-defined punctures, slightly larger and denser than on prothorax and head. Abdomen with numerous asperate punctures; under-surface of sixth segment with a deep narrow notch. Legs not very long, front femora stout and obtusely dentate, front tibiae notched at about basal third, four basal joints of front tarsi dilated to form an ovate pad, basal joint of hind tarsi almost as long as three following combined. Length, 8.5-10.5 mm.

♀. Differs in having slightly shorter antennae and legs and abdomen not notched.

Hab.—Queensland: Mackay (R. E. Turner), Bowen (Aug. Simson's No. 955), Townsville (Ejnar Fischer), Claudie River (J. A. Kershaw); Northern Territory: Darwin, Adelaide River (British Museum). Type, I. 12400.

Structurally very close to *D. mastersi,* except that the head is somewhat larger and with longer antennae, but very differently coloured. Of the eight specimens under examination all have the apical segments of abdomen black, six have the femora and tibiae either entirely black or with only the knees and tips of tibiae obscurely paler (on one the front tibiae are entirely pale), but two have the legs entirely reddish; the clenched mandibles appear to be completely black, but on being forced open they are seen to be partly red. Each mandible has a bicuspidate tooth about one-third from apex, the cusps varying in size, and sometimes slightly in position, there is also a small tooth lower down. On one specimen one wing is exposed and seen to be ample, as it extends almost to the tip of the abdomen.

Dolicaon pedatus, n. sp.

♂. Dark castaneous; two apical segments of abdomen and parts of mandibles black; apical half of antennae paler than basal half.

Elytra no longer than prothorax, and scarcely as wide as its widest part. Length, 10 mm.

Hab.—Northern Territory: King River (W. McLennan). Type (unique), in National Museum.

In general appearance close to the preceding and with sculpture as described for that species, but slightly thinner and darker, clothing slightly denser, head slightly less transverse, eighth to tenth joints of antennae quite globular and not transverse, punctures everywhere smaller and denser, especially on the elytra, and the elytra themselves smaller. Each mandible has a bicuspidate tooth on the apical third and a feeble projection (scarcely a tooth) nearer the base. Remnants of wings are present, but are useless for flight, as they are not half the length of the elytra.

CRYPTOBIUM, Mannerh., Cat., p. 278.

ABDOMINALE, Mots. Q., N.S.W., W.A., N.W.A.. N.T.
apicale, Macl.
ADELAIDAE, Blackb. S.A., W.A.
DELICATULUM, Blackb. S.A.
ELEGANS, Blackb. V., S.A.
FRACTUM, Fvl. Q., N.S.W., V., Tas., S.A., W.A.
MASTERSI, Macl. Q., N.S.W., V., W.A., N.W.A., N.T., C.A.
var. *walkeri,* Bernh., Arkiv for Zool., x. (No. 5), p. 5.
MYRMECOCEPHALUM, Lea. Q., N.S.W., N.T.
PICEUM, Fvl. Q.
SANGUINICOLLE, Bernh., Arkiv for Zool., xiii. (No. 8), p. 14. Q.
VARICORNE, Blackb. S.A.

CRYPTOBIUM MASTERSI, Macl.

C. walkeri, Bernh., var.

The description of *walkeri* is but little more than a comparison with *mastersi,* and the differences pointed out are to be noticed on the specimens I have already[26] noted as a variety of that species.

N. var. Two specimens from North-western Australia represent another variety; they differ from the typical form in having the fifth abdominal segment entirely pale, the front part of the head shining, and with much sparser punctures than usual.

(26) Lea, Proc. Linn. Soc. N.S. Wales, 1904, p. 73.

CRYPTOBIUM SANGUINICOLLE, Bernh.

In general appearance this species is close to *C. mastersi*, except that the elytra are uniformly dark; the specimens before me are from Townsville, Mackay, and the Coen River.

CRYPTOBIUM FRACTUM, Fvl.

A specimen, from Bowen, probably belongs to this species, but differs from typical ones in having the prothorax and base of head of a dingy red, possibly from immaturity.

Cryptobium hoplogastrum, n. sp. Figs. 27 and 32.

♂. Black; mandibles red, most of femora flavous, rest of legs deeply infuscated, maxillary palpi with apical joint flavous, basal ones reddish, the others infuscated. Head, sides of prothorax and of elytra, and sides and apex of abdomen with dark straggling hairs, elytra with very short pubescence, somewhat longer on abdomen.

Head subquadrate, hind angles rounded off; a deep median line in front, becoming finer and disappearing about one-third from neck; with large and numerous but irregularly distributed punctures. Mandibles long, with an acutely tricuspidate tooth near middle. Antennae with basal joint as long as four following combined. Prothorax slightly longer than wide, slightly narrower than head, almost parallel-sided, angles slightly rounded off; with an irregular row of rather large punctures on each side of middle, the sides with more numerous ones. Elytra slightly wider than head, about once and one-third the length of prothorax; with dense and sharply-defined punctures of moderate size. Abdomen with rather small, sparse, and rugose punctures, but becoming larger on under-surface, third segment on under-surface with a large acute process, passing fourth and overhanging base of fifth segment, sixth triangularly notched at apex. Length, 7-8 mm.

♀ Differs in having the head smaller and less quadrate, without the median line, prothorax as wide as head and abdomen simple.

Hab.—Western Australia: Swan River and Bunbury (A. M. Lea).

Differs from *C. fractum* and *C. varicorne* in being more robust, with notably coarser punctures and somewhat shorter prothorax, but from those and all other species known to me it is abundantly distinct by the remarkable armature of the male abdomen. On the type the tips of the antennae and of the abdomen are obscurely diluted with red. Another male, which agrees perfectly in structure with the type, may be immature, parts of its abdomen (including the remarkable process), the shoulders, and tips of elytra are obscurely reddish, and the prothorax still more obscurely so.

Cryptobium bicuspidatum, n. sp. Fig. 28.

♂. Shining black; mandibles and elytra red, legs flavous, tibiae and coxae more or less deeply infuscated, two or three basal joints of antennae reddish, two or three apical ones obscurely flavous, the intervening ones deeply infuscated. Head, sides of prothorax and of elytra, sides and apex of abdomen, with straggling dark hairs, elytra and abdomen rather sparsely pilose.

Head moderately long, narrower in front of than behind eyes; with large and numerous punctures, sparser between antennae than elsewhere. Mandibles long and acute, about middle with an acutely bicuspidate tooth. Antennae with first joint about as long as four following combined, second and third sub-equal, fourth to tenth subglobular, becoming feebly transverse, eleventh slightly

longer. Prothorax distinctly longer than wide, subcylindrical, angles slightly rounded off; with an iregular (semidouble) row of fairly large punctures on each side of middle, the sides with more numerous ones. Elytra distinctly wider than prothorax and slightly longer; with fairly regular rows of rather large punctures, but becoming confused posteriorly. Abdomen with fairly numerous small punctures, sixth segment largest of all, its under-surface depressed in middle of apex, with a slight tubercle behind the depression, the following segment deeply notched. Length, 6-6.5 mm.

♀. Differs in having the head slightly smaller, antennae and legs somewhat shorter, and under-surface of abdomen simple.

Hab.—New South Wales: Sydney (H. J. Carter). Type, I. 12646.

In general appearance like *Lathrobium elongatulum,* but basal joint of antennae longer and less cylindrical; in appearance also close to *L. basipenne* and *Scimbalium simplarium,* but punctures and antennae different; at first glance it looks like small *Dicax deserti,* with pale legs, but with the antennae of *Cryptobium;* structurally it is close to *C. varicorne* and *C. cribripenne,* but the elytra are differently coloured and with different punctures. The tips of the abdominal segments are obscurely reddish; the male has a slight tubercular swelling on the under-surface of the sixth segment, but it does not extend to the tip of its own segment, instead of passing beyond the following one, as on the male of *C. hoplogastrum.*

Cryptobium spissipenne, n. sp.

♂. Black; mouth parts, antennae (some of the median joints infuscated), palpi and legs more or less flavous. Head, sides of prothorax and of elytra, and sides and tip of abdomen with straggling dark hairs; elytra and abdomen with short and not very dense pubescence.

Head rather large, hind angles strongly rounded off; very finely shagreened, with numerous fairly large punctures, becoming crowded about base and sparser in front. Mandibles long and acute, near middle with a strong and acutely bicuspidate tooth. Antennae with basal joint slightly longer than four following ones combined. Prothorax slightly longer than wide, subcylindrical, angles slightly rounded off; with dense and sharply-defined punctures of medium size, but absent from a polished median line. Elytra distinctly wider and slightly longer than prothorax; with sharply-defined punctures about as large as those on prothorax, but much more crowded. Abdomen with dense and rather small asperate punctures, becoming sparser posteriorly; under-surface of subapical segment deeply notched. Length, 6-8 mm.

♀. Differs in having the head smaller, antennae and legs slightly shorter, and abdomen not notched.

Hab.—Queensland: Stewart River (W. D. Dodd), Mackay (National Museum from R. E. Turner). Type, I. 12619.

In size and appearance like *C. varicorne* and *C. fractum,* but elytral punctures denser, without the least trace of seriate arrangement, head larger and less polished, and its punctures denser; in appearance it is also close to *C. hoplogastrum,* but the head is shagreened, legs paler, and abdomen of male very different. Parts of the under-surface are usually obscurely reddish, the knees are sometimes slightly darker than the adjacent parts, but no parts of the legs are conspicuously infuscated. On three (of the nine) specimens before me the prothorax is obscurely paler than the adjacent parts, but it is not distinctly reddish, the infuscation of the antennae varies in extent and intensity.

Cryptobium kershawi, n. sp.

♀. Reddish-brown, elytra and two apical segments of abdomen blackish, most of femora flavous, trochanters and tarsi redder, rest of legs deeply infuscated. Prothorax and elytra glabrous, except for short and sparse clothing at sides, rest of upper-surface finely pubescent.

Head rather elongate, sides behind eyes rather strongly rounded and deeply constricted at neck, two subfoveate impressions between antennary ridges; with crowded and not very large but sharply-defined punctures. Mandibles long and acute, a large compound tooth about the middle. Antennae moderately stout, first joint almost as long as five following combined, ninth and tenth scarcely longer than wide. Prothorax much longer than wide, widest at about apical third, sides thence strongly rounded to apex, and gently narrowed (with a slight incurvature) to base, hind angles almost rectangular; with coarse irregularly crowded punctures, leaving a distinct median line, but this with minute punctures. Elytra much wider than prothorax and slightly longer, with strong crowded punctures, a few of which are transversely confluent. Abdomen with crowded subrugose punctures, smaller than on any other portion of upper-surface, and slightly smaller than on its under-surface; anal styles long. Length, 9.25 mm.

Hab.—Queensland: Claudie River (J. A. Kershaw). Type (unique), in National Museum.

In size and general appearance this beautiful species is fairly close to *C. sanguinicolle*, but head paler and antennae stouter, elytra with coarser punctures, the prothorax with coarser and denser ones, leaving much less of the middle impunctate; the punctures on each side of the median line are so large and close together that it appears to be a slightly elevated ridge. The head is subopaque, the rest of the upper-surface highly polished. The left mandible has three acute projections forming a tricuspidate tooth, the right one has but two projections, of these, however, the posterior one is stouter and less acutely pointed than the other.

Cryptobium nitidicolle, n. sp.

♀. Black, under-surface blackish-brown, mandibles and legs brownish-red, antennae somewhat darker, palpi paler. Head, sides of prothorax and of elytra, sides and tip of abdomen with straggling dark hairs; head, elytra, and abdomen rather densely pubescent.

Head rather long; with dense and small but sharply-defined punctures, rather larger in front of eyes than elsewhere, but becoming smaller on clypeus. Mandibles long, strong, and acute, each about middle with an acutely tricuspidate tooth. Antennae with joints proportioned as in preceding species. Prothorax subcylindrical, distinctly longer than wide, front angles rather strongly rounded off, the hind ones less strongly; with dense and rather large punctures, leaving a polished median line. Elytra slightly longer than prothorax and much wider; with crowded but sharply-defined punctures. Abdomen with punctures somewhat as on base of head; anal styles long. Length, 11.5 mm.

Hab.—Northern Territory: Oenpelli (P. Cahill). Type (unique), in National Museum.

Allied to the preceding species, but more densely clothed, larger and more robust, head, abdomen, and legs darker, and head, prothorax, and elytra with smaller punctures; structurally it is fairly close to *C. mastersi* and *C. sanguinicolle*, but the prothorax is entirely dark and legs nowhere flavous. The prothorax is glabrous, except at the sides, and in consequence appears more highly polished than the rest of the upper-surface.

DESCRIPTIONS OF NEW AUSTRALIAN LEPIDOPTERA.

By Oswald B. Lower, F.E.S., F.Z.S., Lond.

[Read November 9, 1922.]

OECOPHORIDAE.

Tisobarica habromorpha, n. sp.

♀, 16 mm. Head yellow, tinged with carmine on sides. (Palpi broken.) Antennae and legs ochreous, legs banded with fuscous. Abdomen ochreous. Forewings elongate, costa hardly arched, termen oblique; yellow, with carmine markings, more or less edged with blackish; an oblique basal streak; a moderately broad outwardly oblique fascia from one-sixth of costa to dorsum at one-third, with an outward angulation above dorsum; a broad outwardly oblique fascia, from costa about middle to beyond middle of dorsum, touching angulation of previous fascia, fascia constricted above middle; a similar fascia, parallel to last, from costa at about three-quarters to tornus; these two last fasciae enclose a roundish spot of ground-colour just above middle; a fascia along termen to tornus, rapidly attenuated on lower half, and joining previous fascia at termination; cilia yellow. Hindwings and cilia orange-yellow.

Hab.—Dorrigo, New South Wales; two specimens in March.

Pyrgoptila penthistis, n. sp.

♂, ♀, 25-28 mm. Head yellowish-white. Antennae, palpi, and thorax dark fuscous, thorax with a moderate whitish posterior spot. Abdomen ochreous-fuscous. Legs fuscous, obscurely banded with whitish, posterior pair ochreous. Forewings elongate, moderate, costa gently arched, more strongly towards apex, termen oblique; dark fuscous, becoming tinged with ochreous on posterior half of wing; markings white; a somewhat deltoid spot on dorsum moderately large, at one-third from base; a lunate mark above dorsum, on fold, about middle; a curved spot in middle of wing, at posterior end of cell, preceded by a suffused whitish spot; a narrow elongate streak along dorsum near tornus; a curved streak between this and lunate mark, hardly touching dorsum; cilia dark fuscous, chequered with black and whitish spots at base. Hindwings fuscous-grey; cilia greyish-fuscous, darker basally.

Hab.—Dorrigo, New South Wales; five specimens in March.

Ethmia heliomela, n. sp.

♂, 24 mm. Head, palpi, antennae, and thorax dark fuscous. Abdomen dark fuscous, posterior two-thirds strongly tinged with orange. Legs dark fuscous. Forewings elongate, moderate, costa gently arched, termen rounded, oblique; dark bronzy-fuscous, without markings; cilia bronzy-fuscous. Hindwings orange; a broad, bronzy-fuscous apical patch narrowly continued along termen to tornus; cilia dark fuscous on apical patch, remainder orange.

Hab.—Mount Tambourine, Queensland; three specimens in October.

Barea chlorozona, n. sp.

♂, ♀, 25 mm. Head dull whitish. Palpi and antennae dull fuscous. Thorax dull whitish, faintly greenish tinged. Abdomen grey-whitish. Legs dark fuscous. Tibiae and tarsi ringed with whitish, posterior pair ochreous.

Forewings elongate, moderate, costa gently arched, termen obliquely rounded; dull whitish, sometimes fuscous tinged; markings dull greenish; some irregular marks towards base; a broad fascia, somewhat suffused, from costa about one-quarter to one-quarter dorsum, sometimes with two or three fuscous spots throughout; a similar, but more obscure fascia, from middle of costa to middle of wing, thence coalescing into general ground-colour which becomes dull greenish on posterior half of wing; an obscure, slightly-curved fascia from costa at five-sixths to just before tornus, preceded by a similar, but shorter fascia, which is interrupted on costa by a spot of ground-colour; cilia whitish, with a greenish basal line. Hindwings grey-whitish; cilia grey.

Hab.—Dorrigo, New South Wales; five specimens in March.

Barea lamprota, n. sp.

♀, 33 mm. Head, palpi, antennae, and thorax dark fuscous, thorax with two small whitish posterior crests. Abdomen ochreous, with whitish segmental margins. Legs fuscous, posterior pair yellowish. Forewings rather broad, costa gently arched, termen obliquely rounded; fleshy-white, strongly tinged with fuscous; markings black; a thick short longitudinal streak from base along fold to one-third, with an angular protuberance above in middle; a round spot just above the termination of streak; a short mark at base, just above dorsum; a suffused spot on costa at one-fourth; a moderately thick transverse fascia, from two-thirds of costa to five-sixths dorsum, broadest on costa, and containing two black discal spots, one in middle and one obliquely before and below; a curved dotted line before termen, indented at one-third; veins more or less outlined in black towards termen; cilia light fuscous, mixed with darker and with a fleshy-white basal line on upper two-thirds. Hindwings orange-yellow; a fuscous apical patch, continued as a fine line along termen to two-thirds; cilia dark fuscous, with a darker basal line.

Hab.—Dorrigo, New South Wales; two specimens in March.

Eulechria deltoloma, n. sp.

♂, ♀, 20-22 mm. Head yellow. Palpi fuscous, with a whitish apical band, terminal joint greyish. Antennae fuscous, ciliations two. Abdomen greyish-ochreous, anal tuft orange. Anterior and middle legs greyish, mixed with fuscous, posterior pair grey-whitish. Forewings elongate, moderate, costa hardly arched, termen obliquely round; dull ochreous-white, more or less minutely irrorated with fuscous; a fuscous, wedge-shaped, elongate mark on costa, between one-fourth and three-fifths; three small fuscous dots, placed longitudinally below elongate mark, first at anterior end of elongate mark, second in middle, and third at posterior extremity of mark; an additional dot immediately below third; a fuscous line, from costa at five-sixths to tornus, strongly indented below costa and becoming dot-like below indentation; posterior of wing beyond this line more strongly infuscated; cilia ochreous, with some scattered black scales. Hindwings fuscous; cilia as in forewings.

Hab.—Dorrigo, New South Wales; seven specimens in March and October.

Eulechria polistis, n. sp.

♀, 25 mm. Head, palpi, and antennae ashy-white, terminal joint of palpi fuscous tinged. Thorax cinereous-grey, collar paler. Abdomen grey-whitish. Legs white, anterior tibiae and tarsi banded with fuscous. Forewings elongate, rather broad, costa gently arched, termen obliquely rounded; dull white, faintly suffused with pale fuscous; three irregular, oblique, pale-fuscous fasciae, reaching more than half across wing; first from costa at one-sixth, second from costa at about one-fourth, third from costa in middle and reaching to above tornus;

six dark-fuscous equidistant costal dots, first at commencement of third fascia and sixth at apex; from the fifth dot is emitted a fine, waved, fuscous line of suffused dots, line indented below costa and terminating at tornus; two fine fuscous dots at posterior end of cell, one above the other; cilia barred with pale fuscous. Hindwings pale whitish-fuscous, darker on apical portion.

Hab.—Dorrigo, New South Wales; two specimens in October.

Cryptolechia alphitias, n. sp.

♂, ♀, 16-20 mm. Head whitish. Antennae fuscous-whitish. Palpi fuscous, suffused with whitish. Thorax grey-whitish, tinged with fuscous anteriorly. Abdomen grey. Legs fuscous, posterior pair grey-whitish. Forewings elongate, moderate, costa gently arched, termen obliquely rounded; dull whitish, suffusedly irrorated with pale fuscous; markings fuscous; a curved series of three obscure basal spots; an obscure outwardly-curved narrow fascia, from costa about one-fourth to dorsum at one-fourth; a moderately broad, suffused, and somewhat interrupted direct postmedian fascia, darkest on margins; a curved series of dots, parallel to termen, from costa at five-sixths to tornus, indented below costa; cilia grey-whitish with an obscure fuscous basal line. Hindwings grey-whitish; cilia grey-whitish, tinged with fuscous.

Hab.—Dorrigo, New South Wales; four specimens in October.

XYLORYCTIDAE.

Catoryctis perichalca, n. sp.

♀, 25-27 mm. Head, palpi, and thorax silvery-white, second joint of palpi fuscous, patagiae light ochreous-fuscous. Antennae white, annulated with fuscous above. Abdomen ochreous-fuscous, segmental margins dull whitish. Legs ochreous, anterior and middle pair suffused with whitish. Forewings elongate, costa rather strongly arched, termen obliquely rounded; bright ochreous-fuscous, with silvery-white markings; a narrow subcostal streak from near base to middle, touching costa on anterior end and becoming attenuated posteriorly; two very fine short streaks, somewhat obscure, between posterior extremity of subcostal streak and costa at four-fifths, both touching costa; a broad, clear, longitudinal streak, from base to just above middle of termen, posterior half somewhat attenuated; a similar streak from base along dorsum to one-sixth, thence continued above dorsum to termen above tornus, attenuated at base; cilia ochreous-fuscous, becoming grey-whitish around tornus, and silvery-white below apex, caused by the median line being continued through cilia. Hindwings fuscous; cilia fuscous-whitish.

Hab.—Highbury, South Australia; two specimens in October.

Crypsicharis triplaca, n. sp.

♂, 22 mm. Head, palpi, antennae, and thorax snow-white, second joint of palpi externally fuscous, antennal ciliations 3, palpi with fuscous anterior band. Abdomen dull ochreous. Legs fuscous, posterior pair whitish. Forewings elongate, moderate, costa gently arched, termen oblique; white, with fuscous markings; a moderate somewhat ovoid spot above dorsum on fold, in middle; an erect, moderately-thick, fascia-like streak, from dorsum before tornus, reaching three-quarters across wing, upper half divided into two roundish spots; cilia whitish, terminal half fuscous. Hindwings and cilia grey-whitish, cilia tinged with fuscous near base.

Hab.—Duaringa and Toowoomba, Queensland; two specimens in October.

ELACHISTIDAE.

Limnoecia loxoscia, n. sp.

♀, 12 mm. Head whitish. Palpi whitish, fuscous tinged. Antennae and thorax fuscous. Abdomen greyish. Legs fuscous. Forewings elongate-lanceolate; dark fuscous, with creamy-white markings; an ovoid basal spot; a moderately broad oblique fascia, from costa near base to near middle of wing, not reaching dorsum, but attenuated posteriorly; a similar fascia, from costa in middle, extending to tornus; a small triangular spot on costa, just above termination of last streak; cilia dark fuscous, becoming broadly creamy-white around tornus and upper third of termen. Hindwings and cilia fuscous.

In one specimen the second fascia is obsolete on costal portion, thus becoming a short longitudinal streak.

Hab.—Dorrigo, New South Wales; three specimens in October and November.

Parectropa clethrata, n. sp.

♂, 16 mm. Head snow-white. Thorax white, patagiae brownish-ochreous. Antennae fuscous, whitish beneath. Palpi white. Abdomen fuscous. Legs fuscous, anterior and middle pair suffused with white. Forewings elongate-lanceolate; white, with well-defined ochreous markings; a thick streak above fold, from base to indentation of first fascia, becoming costal anteriorly; first fascia from costa at one-third, outwardly oblique to middle of wing, thence obliquely inwards to dorsum before middle, and continued more or less to base; second fascia similar, from costa at about middle to dorsum at three-quarters, interrupted by a streak of ground-colour above angulation; a wedge-shaped costal spot, directed towards termen, but not reaching it, at about five-sixths; a similar spot, almost at apex; an irregular tornal spot; cilia fuscous, with a white tooth below middle. Hindwings narrow-lanceolate; grey; cilia grey-whitish.

Hab.—Wayville, South Australia; three specimens, in September, at light.

AUSTRALIAN FUNGI: NOTES AND DESCRIPTIONS. No. 4.

By J. Burton Cleland, M.D., and Edwin Cheel, Botanical Assistant, Botanic Gardens, Sydney.

[Read November 9, 1922.]

Plates I. and II.

This paper continues our records of the larger fungi of Australia, the Basidiomycetes more particularly, both as to the occurrence of species and as to their distribution and seasonal occurrence. Where we have already dealt with a species in this series, this is indicated by a reference in brackets (*e.g.*, III., 179) following the serial number. Our previous papers appeared in these Proceedings as follows:—No. 1, xlii., 1918, p. 88; No. 2, xliii., 1919, p. 11; and No. 3, xliii., 1919, p. 262. As previously stated, the colour tints when specifically noted are based either on Dauthenay's "Repertoire de Couleurs . . ." or on Ridgway's "Colour Standards and Colour Nomenclature."

We would like again to express our appreciation at being enabled to reproduce coloured plates of some of the species with which we deal, and to congratulate Miss Phyllis Clarke, of Sydney, and Miss R. C. Fiveash, of North Adelaide, on their admirable delineations in water-colour. We again owe much to Mr. C. G. Lloyd, of Cincinnatti, and from many friends in Australia we have received valuable help in the shape of specimens.

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WHITE-SPORED AGARICACEAE.

Amanitopsis.

253. *Amanitopsis subvaginatus*, n. sp.—Pileus up to 1¼ inch in diameter, convex, "Ashy-Grey" (Dauthenay, pl. 358, Ton 3), mealy, edge striate. Gills just reaching the stem, close, white, edge finely serrate. Stem, 1½ inch long, moderately stout, mealy white, solid, base a little bulbous. Volva marginate, colour of pileus. Spores spherical, with a small pedicle, 7·5 to 9 μ. On the ground, usually in subclayey pockets in the Hawkesbury sandstone by the sides of paths. Cremorne Point and Bradley Head, Sydney Harbour, March, April, November, December (Miss Clarke, Watercolour No. 171).

Pileus ad 3·2 cm. latus, convexus, subcineraceus, farinaceus, margine striato. Lamellae ad stipem assecutae, confertae, albae, marginibus subserratis. Stipes ad 3·9 cm. altus, subrobustus, farinaceus, albus, solidus, ad basem sub-bulbosus. Volva marginata, subcineraceus. Sporae subsphaericae, 7·5-9 μ. (Pl. i., fig. 6.)

Mycena.

254. *Mycena epipterygia*, Scop.—We refer the following to this species, though our plants are smaller and we have no note of a decurrent tooth to the gills. Pileus and stem glutinous, and both when young in colour near Sulphine-Yellow (Ridgway, pl. iv.), the pileus later near Dark Olive-Buff (pl. xl.). Pileus ⅜ inch high, five-sixteenth inch in diameter, at first ovate conical, then conico-campanulate, gibbous, apex darker, periphery paler, rugose. Gills ascending, adnate, rather ventricose, moderately close, white. Stem up to 3 inches high, slender, hollow, a little strigose below. Spores 8 x 4·8 μ; no cystidia seen. Attached to buried sticks, etc., Mount Lofty, S.A., June (Miss Fiveash, Watercolour No. 13). (Pl. ii., fig. 3.)

Marasmius.

255. *Marasmius subinstitius*, n. sp.—The following seems allied to *M. institius*, differing in the absence of umbilication, in the dark stem, and in the presence of cystidia. Pileus ⅛ inch in diameter, convex, occasionally reaching ¼ inch when more expanded, slightly coarsely rugose, pallid brownish, surface matt. Gills adnate, distant, relatively few, alternate ones short, deep, colour of pileus. Stem up to 1¼ inch high, blackish, like horsehair, finely villous, abruptly leaving the matrix. Spores elongated, one end more pointed, 8·5 x 2·8 μ; a few thick-walled cystidia with rough apices, 52 to 60 x 12 μ. On dead leaves, sticks, etc., Mosman, Sydney, May, 1919 (Miss Clarke, Watercolour No. 205). (Pl. i., fig. 5.)

Pileus 3-6·2 mm. latus, convexus, subrugosus, pallido-subfuscus. Lamellae adnatae, distantes, subpaucae, pallido-subfuscae. Stipes ad 3·2 cm. altus, subniger, similis equino-crini, villosus. Sporae elongate, 8·5 x 2·8 μ; cystidia apicibus asperis.

256. *Marasmius rugoso-elegans*, n. sp.—We refer the following to a new species. Pileus ¼ to ⅜ inch broad, ¼ inch high, at first rather conico-hemispherical, then hemispherical or rather bell-shaped, slightly gibbous, coarsely rugose, surface matt, edge turned in when young, near Brownish-Terra-cotta (Dauthenay, pl. 322, Ton 4), the ridges darker, brittle. Gills adnate, attached to a more or less definite collar, distant, often short, about 15 in number, white to cream or pinkish-white. Stem ½ to 2 inches or more long, hair-like, dark brown or Purple-black (Dauthenay, pl. 345, Ton 3) except pallid to whitish just below the pileus, smooth, abruptly piercing the matrix or (in the Dorrigo specimens) with a pad of fluffy white mycelium at the base, the fallen leaves, twigs, etc., forming the substratum on which it grows being covered with a pallid whitish or greyish

mycelium. Spores (?) elongated, broader at one end, 15·5 x 3·4 μ; in the Dorrigo specimens some spores were seen 6·8 x 5·5 μ. New South Wales: Mosman, April (Miss Clarke, Watercolour No. 178); Narrabeen, February (Herb., J. B. C., Formalin Sp. No. 274); Dorrigo, January.

The Dorrigo specimens differ from the other two collections in being somewhat taller (2 inches or more high) and in the colour of the pileus being more reddish. The spores seen were doubtful, but if the figures given actually represent the spores of the plants in the different collections, then the difference in dimensions would indicate that the Dorrigo ones belonged to a different species.

Pileus 6-9 mm. latus, 6 mm. altus, conico-hemisphaericus, deinde hemisphaericus vel campanulatus, subgibbosus, rugosus, subfuscus 'terra-cotta.' Lamellae adnatae, adjunctae collari, distantes, circiter 15, albidae. Stipes 1·2-5 cm. altus, similis crinis, subniger, infra pileum albidus, glaber.

CANTHARELLUS.

257. *Cantharellus cinereus*, Fr., var. *australis*, var. nov.—This plant seems to be an Australian representative of *C. cinereus*, but to differ from the typical form sufficiently to warrant separation as a variety. Our specimens show a general darker colour than those figured by Cooke, the stem does not so gradually expand from below up, and the spores are slightly larger (8 to 8·5 x 5·2 to 6 μ) than the measurements given by Massee (7 x 5 μ).

Pileus up to 1½ inch in diameter, Warm Sepia (Dauthenay, pl. 305, Ton 1) to Sepia (pl. 300, Ton 4), somewhat strigose, infundibuliform and opening into the hollow stem. Gills greyish (Purplish-tinted White, pl. 6, Ton 4), decurrent, markedly anastomosing, thick and irregularly crenate. Stem up to 1¼ inch high, blackish (Neutral Tint, pl. 361, Ton 4, to Dark Neutral Tint, pl. 346, Ton 4), hollow, often flattened, up to ¼ inch thick. Spores 8 to 8·5 x 5·2 to 6 μ. In leafy mould under dense growth of trees, Bradley Head, Sydney, May, 1919 (Miss Clarke, Watercolour No. 203).

Pileus ad 3·9 cm. latus, 'sepia,' substrigosus, infundibuliformis, in stipem cavum patens. Lamellae subcineraceus, decurrentes, crassae, anastomosibus, crenatae irregulariter. Stipes ad 3·2 cm. altus, ad 6 cm. latus, subniger, cavus. Sporae 8-8·5 x 5·2-6 μ. (Pl. i., fig. 2.)

258. *Cantharellus triangularis*, n. sp.—Pileus ⅜ inch in diameter, convex, with a broad very dark-brown umbo, the rest of the surface smoky-brown and slightly striate. Gills thick, moderately distant, dingy pallid, rarely forking, deeply decurrent. Total height ¾ inch, of stem only ⅜ inch, stem moderately slender, solid, later hollow, chocolate-brown, with a little white fluffy mycelium at the base. Flesh pale chocolate. Spores elongated pear-shaped, 8·5 to 13·8 x 5 μ, usually 8·5 to 10·5 x 5 μ. On the ground, Neutral Bay, Sydney, December 1, 1917 (Miss Clarke, Watercolour No. 173; Herb., J. B. C., Formalin Specimen No. 295).

Pileus ad 1 cm. latus, convexus, umbone subnigro-fusco, fumoso-fuscus, substriatus, lamellae crassae, subdistantes, fusco-pallidae, raro furcatae, perdecurrentes. Stipes ad 1 cm. altus, subtenuis, solidus deinde cavus, cacao-fuscus. Caro pallido-cacao-fusca. Sporae elongata-pyriformes, 8·5-13·8 x 5 μ. (Pl. i., fig. 3.)

SCHIZOPHYLLUM.

259. *Schizophyllum commune*, Fr. Cooke, Handb. Austr. Fungi, No. 525 (all the States). New South Wales: Scone, October, in dying parts of Prickly Pear *(Opuntia inermis)*; Blackheath, November, on telegraph post, even on the tarred part. Northern Territory: Darwin, April (Dr. Leighton Jones—a laciniate form, *S. multifidum*—identified by Lloyd, No. 314).

Lentinus.

260 (iii., 142). *Lentinus fasciatus*, Fr. New South Wales: Myall Lakes, May.

Lenzites.

261 (iii., 153). *Lenzites repanda*, Mont. Queensland: Bunya Mountains, October.

BROWN-SPORED AGARICACEAE.

Flammula.

262 (i., 43). *Flammula excentrica*, Clel. and Cheel. New South Wales: Kendall, March.

Hebeloma.

263 (i., 26). *Hebeloma subcollariatum*, Berk. and Br. New South Wales: Sydney, December; Narrabri, May, June. South Australia: On dung, Berri, January; on dung, Mount Lofty, September, pileus near Ochraceous-Buff (Ridgway, pl. xv.), gills when young near Hair Brown (pl. xlvi.), becoming Saccardo's Umber (pl. xxix.).

PURPLE-SPORED AGARICACEAE.

Psalliota.

264 (i., 56). *Psalliota campestris*, (L.). In the *Sydney Morning Herald* for May 25, 1921, it is recorded that a mushroom collected near Goulburn measured 42 inches in circumference, 13 inches in diameter, and had a stem 2¾ inches in thickness. In the Sydney *Evening News* for April 10, 1913, another mushroom taken near Spring Vale, Victoria, measured 56½ inches in circumference and 27 inches round the stalk, and weighed 13 lbs. 2 ozs. The species is not recorded in either case, but the specimens were probably the same as those usually sold in the shops, *viz.*, a form of *P. campestris*.

265. *Psalliota arvensis*, Schaeff. Cooke, Handb. Austr. Fungi, No. 306 (New South Wales, Victoria, Tasmania). South Australia: Adelaide, August.

266 (i., 57a). *Psalliota arvensis*, var. *iodoformis*, Clel. and Cheel. New South Wales: Sydney, February and May; also in a clump, April, the pilei showing scattered, fine, warty, brownish scales, giving a speckled appearance.

Stropharia.

267 (i., 61). *Stropharia semiglobata*, Batsch. (*S. stercoraria*, Fr.). South Australia: Adelaide, August; Mount Lofty Ranges, November; Mount Compass, October. New South Wales: Scone, October.

Psilocybe.

268 (i., 73). *Psilocybe ceres*, Cooke and Massee. New South Wales: Sydney, April, June, pileus near Morocco Red (pl. i.), gills near Mummy Brown (pl. xv.); Kangaroo Valley, June, pileus near Vinaceous Rufus in parts (pl. xiv.), gills near Prout's Brown (pl. xv.) Victoria: Craigie, June, in *debris* at foot of red gums in creek, rare (E. J. Semmens, No. 41). South Australia: Waterfall Gully, April, September, amongst decaying wood, pileus variously tinted, in places Apricot Orange (pl. xiv.), gills irregularly clouded with tints of Saccardo's Olive (pl. xvi.); amongst grass under trees and pines, Glen Osmond, June, August; National Park, May.

Hypholoma.

269 (i., 67). *Hypholoma fragile*, Peck. New South Wales: Sydney, March. Colour tints noted (Dauthenay). Pileus in the centre near Madder Brown,

Brownish Terra-cotta (pl. 334, Ton 4), paling towards the periphery, which is quite light; pileus near Pale Yellowish Flesh (pl. 68, Ton 4), shading into but usually lighter than Snuff Brown, Deep Bistre (pl. 303, Tons 1 to 4). Gills near Pale Blush (pl. 137, Ton 4), but with a pinkish tinge. Spore mass more purple than Otter Brown (pl. 354) and Neutral Tint (pl. 361).

270 (i., 63). *Hypholoma fasciculare*, Huds. New South Wales: Bullahdelah, August.

BLACK-SPORED AGARICACEAE.

COPRINUS.

271. *Coprinus micaceus*, Fr. Clel. and Cheel, Proc. Linn. Soc. N.S. Wales, xli., 1917, p. 854. South Australia: Adelaide, August, September, October.

PANAEOLUS.

272 (i., 75). *Panaeolus ovatus*, Cooke and Mass. New South Wales: 16 miles from Taree, June.

POLYPORACEAE.

BOLETUS.

273. *Boletus subglobosus*, n. sp. The whole plant irregularly globular like a puffball, up to 1 inch long with a stem ¾ inch long. Pileus convex, nearly hemispherical, a little irregular, Yellow-Green (Dauthenay, pl. 16, Ton 1), cracking into small, darker (Otter-Brown, pl. 354, Ton 3) villose scales. Hymenial surface convex with a deep sulcus round the stem, hidden by the filmy pale veil, which breaks to expose the small dingy yellow (paler than Dauthenay's Yellow-Green) pores. Stem ¾ inch long, attenuated downwards, rather slender, ¼ inch thick, yellow-green like the pileus. Flesh shows slight reddish stains where eaten by insects. Slight bluish tint when cut. Spores greenish-yellow microscopically, obliquely oval, one end more pointed, 8·5 to 10 x 5 μ. Bradley Head, Sydney, April, 1917 (Miss Clarke, Watercolour No. 196).

Pileus convexus, subhemisphaericus, subirregularis, flavo-viridis, villoso-squamulosus. Velum filamentosum. Hymenium convexum poris parvis fusco-flavidis et circum stipem cum sulco. Stipes ad 1·9 cm. altus, deorsum attenuatus, subtenuis, flavo-viridis. Sporae 8·5-10 x 5 μ. (Pl. i., fig. 4.)

STIPITATE POLYPORES.

274. *Polyporus (Ganodermus) lucidus*, var. *japonicus*, Fr. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, li., 1918, No. 1. New South Wales: Bulladelah, August, spores oval, thick-walled, 10·5 x 6·8 μ; Kendall, on *Casuarina* stump, August.

275. *Polyporus (Petaloides) rhipidium*, Berk. Clel. and Cheel, Journ. Proc. Roy. Soc. N.S. Wales, li., 1917, No. 11, p. 480. Queensland: Gympie, June. New South Wales: Sydney, March, pileus and pores probably nearest to Fleshy White (Dauthenay, pl. 9, Ton 4); August, at base of *Eucalyptus;* October, pileus pale fawnish or yellowish when fresh, pores whiter, spores elongated, 4·4 to 5·5 x 2·5 to 3 μ; Kurrajong, August; Thirroul, April; Kendall, August. Victoria: 1918 (C. C. Brittlebank). South Australia: Mount Lofty, June.

276. *Polyporus (Petaloides) megaloporus*, Mont. Clel. and Cheel, *loc. cit.*, No. 20. New South Wales: Near Wauchope, February, identified by Lloyd (No. 298).

277. *Polystictus (Petaloides) flabelliformis*, Klotzsch. Clel. and Cheel, *loc. cit.*, No. 28. New South Wales: Kendall, March.

278 (iii., 173). *Polyporus (Merismus) anthracophilus*, Cooke. Forming a huge mass amongst fallen leaves and *debris* near the base of *Eucalyptus*

viminalis, Labill., Mount Lofty, June, pileus chiefly Fuscous and Fuscous Black (Ridgway, xlvi.), passing into Buffy Brown (xl.), pores near to but a little paler than Maize Yellow (iv.), weight 6 lbs., spores oval, 5·3 x 3·5 μ; at base of stumps, National Park, S.A., May, spores elongate, 5 to 8 x 2 2 μ.

279 (iii., 176). *Polyporus (Spongiosus) rufescens,* Pers. We have collected further fruiting specimens from the base of the cultivated olive previously mentioned and from the base of another olive, half a mile away, at Beaumont, near Adelaide. This is probably a destructive fungus to the olive, though the first tree mentioned shows as yet little ill-effects, after nearly five years' observation. In the case of the second tree, however, a large stem above the affected site is dying back. Fruiting bodies, emerging after heavy rain, have been found in January, March, June, July, and December. Spores abundant, elliptical, 5·2 to 5 5 x 3 5 μ.

280. *Polyporus (Spongiosus) Schweinitzii,* Fr. Clel. and Cheel, Jour. Proc. Roy. Soc., N.S. Wales, li., 1917, No. 50, p. 490. New South Wales: Mosman, May, spores 5 x 3 μ; Chatswood, June (Miss Clarke). South Australia: At base of several living trunks of *Eucalyptus obliqua,* L'Her., near Kuitpo Forest May, spores white, subspherical to elliptical, 8 μ, 8 x 5 to 6 5 μ.

281 (iii., 177). *Polyporus (Spongiosus) Albertini,* Mueller. New South Wales: Bullahdelah, August, spores numerous, mostly pale yellowish-brown, some nearly colourless, 5·2 x 3·4 μ; Kendall, March, inside base of burnt trunk, numerous brown spherical spores, 4 μ. In our previous two records, the spores measured about 8 x 6 μ, *i.e.*, were nearly twice as large as in the present two records. In all, the plants resembled so closely *P. Schweinitzii* that they could only be distinguished by the coloured spores. In one of the present and in one of the previous records, the stems were moderately slender.

282 (ii., 88). *Polyporus (Ovinus) basilapiloides,* (McAlp and Tepper). We have been fortunate in finding a number of freshly-developed sporophores of this interesting species at Monarto South, S.A., in May, 1921, and in showing that these arise from a deeply-buried true sclerotium on which is superadded the false sclerotium of mycelium and sand hitherto thought to be the only underground development. The following is our description of the fresh plants: —Pileus convex, up to 3¼ inches in diameter, the centre shallowly pitted by raised brown lines, the depressions paler, edge of the pileus crinkled and irregular—the pitting is in some cases little marked, the lines being replaced by rugosities. Pores up to ¼ inch long, adnate, shortened externally, whitish, orifices small. Substance tough. Stem above ground short, ¾ inch, ½ inch thick, colour of the cap, smooth or reticulated, covered with sand, sometimes as a distinct stem passing down for an inch into the sand and mycelium; the stem is succeeded by irregular swollen masses up to 3 inches in diameter with irregular constrictions, up to 6 inches long, composed of mycelium and sand, without a definite crust; below this false sclerotium is an irregularly rounded or elongated true sclerotium (sizes in inches 3¼ x 2¾, 3 x 2½, and 2 x 1½), with an outer dark crust of mycelium and sand, on section somewhat moist, sticky, cutting like firm cheese, the colour of doughy brown bread, not showing "cells" like the sclerotium of *P. mylittae,* on chewing without taste but with some minute sand grains incorporated in it. One true sclerotium weighed 12¾ oz.; a pileus with false sclerotium 28 ozs. Spores white, elongated, narrow, 14 x 4 5 μ. Colour tints noticed: Pileus at edge near Cinnamon Orange (xxix.), or Mikado Brown (xxix.) to Vinaceous Cinnamon (xxix.) in centre; in other plants near Cinnamon Buff (xxix.) between the reticulations, which are Mikado Brown; stem colour of cap. In sand in mallee country recently burnt over, Monarto South, May 28, 1921. (Pl. ii., fig. 2.)

283. *Polystictus (Lentus) xanthopus*, Fr. Clel. and Cheel, *loc. cit.*, No. 69. Queensland: Imbil, August; Barron Falls, Kuranda, September (Mrs. Fraser).

284. *Polyporus (Lentus) arcularius*, Batsch. Clel. and Cheel, *loc. cit.*, No. 70. New South Wales: Landsdowne, September; Wombeyan Caves, November, spores 6 to 9 x 3 to 3·4 μ, confirmed by Lloyd (Nos. 625 and 626); Tuggerah, October, spores 7 to 8·5 x 2·25 μ.

POLYPORUS.

285 (iii., 178). *Polyporus eucalyptorum*, Fr. New South Wales: Near Bullio, *via* Mittagong, on dead upright trunk, November, spores 8·5 x 6 μ. South Australia: Locality not noted, pores Citron Yellow (pl. xvi.), spores 9·5 x 4·8 to 5·2 μ; on *Eucalyptus viminalis*, Labill., Mount Lofty, June, spores subspherical, thick-walled, 12·5 x 9 μ, 9 μ.

286. *Polyporus ochroleucus*, Berk. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, li., 1918, No. 125. New South Wales: Scone, October. South Australia: Kuitpo, May.

287 (iii., 179). *Polyporus gilvus*, Schw. New South Wales: Kew, January, confirmed by Lloyd (No. 447); on a log, Macquarie Pass, August, identified by Lloyd (No. 427)—"a form with pubescent surface, entitled to a name"; Kendall, December, identified by Lloyd (No. 439), who says, "You seem to have two forms (or species) with you, one with hard brittle flesh, which corresponds with our plant, the other like this with softer flesh. Perhaps this merits a name, but it would be hard to distinguish it."

288. *Polyporus fumosus*, Pers. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, li., 1918, No. 123. Queensland: Imbil, August; Bunya Mountains, October, identified with some doubt by Lloyd (No. 597). New South Wales: Jenolan Caves, November.

289. *Polyporus dryadeus*, Pers. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, li., 1918, No. 145. South Australia: Mount Lofty, on *Eucalyptus obliqua*, L'Her., May, June, July, usually some feet up the trunk, substance cuts easily when fresh and turns slightly yellowish-brown, spores elliptical, one side a little flattened, just tinted, spores 8 x 5 to 6 μ, no setae seen.

290 (iii., 184). *Polyporus sessilis*, Murrill. Queensland: Imbil, August.

POLYSTICTUS.

291 (iii., 169). *Polystictus sanguineus*, L. Fiji (Mrs. Lucas). Queensland: Imbil, August. New South Wales: We have a form from Malanganee, August, intermediate between this species and *P. cinnabarinus* (Lloyd, No. 387).

292 (iii., 170). *Polystictus cinnabarinus*, Jacq. Queensland: Fraser Island (Capt. S. A. White); Bunya Mountains, October. New South Wales: Bullahdelah, August; Nevertire, May. South Australia: Kuitpo Forest, May; Mount Lofty, June; on dead peach branch (Prof. Howchin); Quorn, August; Beltana, August; on fallen logs of *Callitris*, etc., Blinman, August; Ooldea, September, on "burn-burn," native peach, *Fusanus acuminatus*, R. Br. (Mrs. Daisy Bates, per J. M. Black); on dead branch of living cultivated cherry, Norton Summit, December; on dead branches of willow, Wellington, November; Encounter Bay, January; on walnut tree, Port Elliot, February (G. H. Dutton); Currency Creek, January (T. D. Campbell). Western Australia: Roebourne (R. Glen and H. G. Meares).

293 (iii., 171). *Polystictus cervino-gilvus*, Jungh. Queensland: Imbil, August. New South Wales: Bullahdelah, August (Lloyd, No. 587); Kendall, August; Bellinger River, June (Mr. Smithers—"a trametes form," Lloyd, No. 538).

294. *Polystictus versatilis*, Berk. (sometimes placed under *Irpex* or *Trametes*, Lloyd). Cooke, Handb. of Austr. Fungi, No. 766, Queensland, New South Wales, and as *P. venustus*, No. 772, Queensland, Western Australia. Queensland: Stradbroke Island, September (Lloyd, No. 589); on dead stump of *Callitris columellaris*, F. v. M., Bribie Island, Moreton Bay, September (Lloyd, No. 494). New South Wales: On stump of fallen *Callitris robusta*, R. Br., violet tint when fresh, Narrabri, June (Lloyd, No. 539); on fallen *Eucalyptus* branch, Scone, May (Lloyd, No. 327—"old, indurated, and denuded, *P. venustus*, Berk., in this condition"); Kendall, August (Lloyd, No. 580).

295. *Polystictus (Hexagona) luteo-olivaceus*, B. and Br. Cooke, Handb. Austr Fungi, No. 800 (Queensland). Queensland: Imbil, August, Lloyd, No 741). New South Wales: Boatharbour, near Lismore, August (Lloyd, No. 395); on fallen log, Malanganee, August (Lloyd, No. 396); near Wauchope, February (Lloyd, No. 304); National Park, May.

296. *Polystictus subcongener*, Berk. Lloyd, Mycol. Notes, No. 61, p. 898, fig. 1578, and No. 62, p. 935, fig. 1710. Syn., *Daedalea subcongener*, Berk., in Cooke, Handb Austr. Fungi, No. 867. Bellinger River, June (Mr. Smithers). Lloyd, in describing and figuring our specimens, says he can only consider this species as a form of the common *P. occidentalis* with scabrous rather than hirsute surface and larger pores. He points out that the surface is short and subscabrous, not velutinate as described.

297 (iii., 160). *Polystictus elongatus*, Berk. Queensland: Bunya Mountains, October (confirmed, Lloyd, No. 596). New South Wales: Comboyne, September (confirmed, Lloyd, No. 561); on dead trunk of *Pinus*, Centennial Park, Sydney, November (confirmed, Lloyd, No. 471).

298 (iii., 164). *Polystictus occidentalis*, Klotzsch. We have specimens from Fiji (Mrs. Lucas), identified by Lloyd (No. 562 and No. 578, the latter a rather thick form).

299 (iii., 165). *Polystictus (Trametes) Persoonii*, Mont. Lloyd has identified Fiji specimens (No. 571, Mrs. Lucas) for us.

300 (iii., 167). *Polystictus flavus*, Klotz. Queensland: Enoggera, September (confirmed, Lloyd, Nos. 598, 609); Imbil Forest, August. New South Wales: Kangaroo Valley, June (confirmed, Lloyd, No. 543).

301 (iii., 168). *Polystictus versicolor*, L. Queensland. Pileus chiefly between Cinnamon Buff and Clay Colour (Ridgway, xxix.), with darker zones and some bands with a greyish tinge; hymenium near the same colour; Bunya Mountains, October (identified by Lloyd, No. 605, who considers this a distinct and constant form, meriting a name). New South Wales: Bellinger River, June (Mr. Smithers; confirmed, Lloyd, No. 536); Mosman, June, base reduced to a narrow stalk (Lloyd, No. 544); Kangaroo Valley, June, a *Cladoderris* form identified by Lloyd (No. 537); Macquarie Pass, August, "a pale form close to the form called *Polystictus hirsutulus*, Schw." (Lloyd, No. 389); near Robertson, August, departing from the usual form in "the more glabrous pileus and darker pore mouths (Lloyd, No. 390); Kendall, August, a thick form, identified by Lloyd, No. 497; on telegraph poles, causing rotting, Mosman, May, and Neutral Bay, October, identified by Lloyd, "an unusual trametoid form" (No. 470). South Australia: On telegraph post and stumps, Mount Lofty, June, July; on cut stump, a dark greyish-brown form ("a colour form," Lloyd, No. 649), Mount Lofty, June, shed spores sausage-shaped, slightly curved, 5.3 to 7×2 μ; Morialta Falls, October.

302. *Polystictus nigricans*, Lasch. A dark form of *P. versicolor*. Dark, nearly blackish, specimens collected by A. M. Lea, at Wilmot, Tasmania, in January, 1918, and recorded by us in iii., 168, as *P. versicolor*, Lloyd (No. 739)

has been identified as this form. New South Wales: Kendall, "a thick form with surface smoother and darker than usual" (identified by Lloyd, No. 497).

303. *Polystictus ochraceus*, Pers. New South Wales: Jenolan Caves, November, numerous slightly curved spores, 6 to 6·8 x 2 μ (identified by Lloyd, No. 615); ?, young plants, Blue Mountains, May (Lloyd, No. 201).

304. *Polystictus hirsutulus*, Willd. Queensland: Bunya Mountains, October; Imbil, August. New South Wales: Dorrigo, January; Kendall, August; Landsdowne, September; Comboyne, September; National Park, March, May.

Fomes.

305 (iii., 185). *Fomes robustus*, Karst. Queensland: Stradbroke Island, Moreton Bay, September, 1919, numerous subspherical hyaline spores, 6 to 7 μ, no setae; Imbil State Forest, near Gympie, August, 1920, occasional oval hyaline spores, 5·6 μ, a few stout brown setae. South Australia: Mr. Formby, per Prof. Howchin, numerous hyaline subspherical spores, 7 to 7·5 μ, no setae, context when young near Yellow Ochre (xv.), when old near Russet (xv.); at base of sweet almond, Beaumont, Adelaide, May, a few spores hyaline or nearly so, 6 to 6·5 μ, no setae, context near Sudan Brown (iii.), younger parts near Yellow Ochre (xv.); at base of *Rhamnus alaternus*, L., Beaumont, January, spores subspherical, hyaline, 5·5 to 6 μ, no setae; on dead mother stump of coppiced *Euc. odorata*, F. v. M., National Park, May, numerous subspherical or a little irregular hyaline spores, 5·5 to 6·5 μ, occasionally 8 μ, no setae; on *Euc. oleosa*, F. v. M., Monarto South, May, context Sudan Brown (iii.).

306 (iii., 185). *Fomes setulosus*, Petch. South Australia: At base of *Euc. rostrata*, Schl., National Park, May, a few spherical hyaline spores, 6·5 μ, numerous brown pointed setae with swollen bases, 19 x 6·5 μ, context a little darker than Raw Sienna (iii.).

307. *Fomes Calkinsii*, Murrill. Lloyd places this species, described from Florida, under Section 69 of his *Fomes* monograph (context brown, setae none, spores hyaline). He has identified specimens for us (No. 621) collected on the Bunya Mountains, Queensland, in October, 1919, and adds, "A very unusual plant, but the same, as far as I can note, as our Florida species." The numerous spores present in some of our plants vary in colour from nearly hyaline to markedly brown, are subspherical to pear-shaped, and measure 5·2 to 6 μ, 6 x 5·2 μ, 6·8 x 6 μ, 8·5 x 5·2 μ. Setae were not seen. Further specimens were collected on *Casuarina torulosa*, Ait., at Imbil, near Gympie, Queensland, in August, 1920. Spores pallid to yellow-brown, irregular to rather triangular, 5·5 to 7·2 μ, no setae seen.

308. *Fomes torulosus*, Pers. This species comes under Section 70 of Lloyd (context brown, setae present, spores hyaline). In identifying specimens (No. 622) for us, from the Bunya Mountains, Queensland, collected in October, 1919, Lloyd says that the salient features are the soft velutinate pore mouths, the ventricose setae, and the pileus ridges. Specimens were abundant in this locality and were usually applanate. The largest specimen measures 16 inches laterally, 11 inches in depth, and 6 inches vertically. Most of the spores are deeply tinted brown, but some are pale, subspherical, 4 to 6 μ in size. The setae are brown, ventricose at the base, with acuminate apices, and are often bent at an obtuse angle near the base, 31 x 8·5 μ, 24 x 10 μ.

309 (iii., 191). *Fomes durissimus*, Lloyd, Mycol. Notes, No. 62, February, 1920, p. 943. The plants from the Bunya Mountains, appearing under *Fomes pseudosenex* (No. 191) in our third paper, Lloyd has now named as the above (Lloyd, Nos. 493, 563).

310. *Fomes rimosus*, var. *casuarinae*, Clel. and Cheel, Botany of Pilliga Scrub, Bull. 14, For. Comm. of N.S. Wales, 1920. New South Wales: On

Cadellia pentastylis, F. v. M., State Forest, Nandewar Range, near Narrabri, September, dark-brown subspherical spores, 5 μ (G. Burrow); on *Acacia cheelii*, Maiden, Killarney State Forest, near Narrabri, September, old context near Argus Brown (pl. iii.) (G. Burrow). South Australia: On mallee (*Eucalyptus oleosa*, F. v. M.), near Overland Corner, January, spores brown, oval, 7 x 5·3 μ.

311 (iii., 186). *Fomes conchatus*, Pers. New South Wales: On firewood, Sydney, August; Bullahdelah, August.

312. *Fomes applanatus*, Pers. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, li., 1918, No. 114. New South Wales: Macquarie Pass, August (Lloyd, No. 408); on dead river *Casuarina*, Jenolan Caves, November.

313. *Fomes applanatus*, var. *leucophaeus*, Mont. Clel. and Cheel, *loc. cit.*, No. 114a. Queensland: Imbil State Forest, August, spores thick-walled, slightly rough or smooth, 8 to 9 x 5 3 μ.

314. *Fomes applanatus*, var. *nigrolaccatus*, Cooke. Clel. and Cheel, *loc. cit.*, No. 114d. Queensland: On fallen *Casuarina* (?), Bribie Island, September, with distinct black laccate crust in places.

HEXAGONA.

315. *Hexagona Gunnii*, Hook. Clel. and Cheel, Jour. Proc Roy. Soc. N.S. Wales, li., 1918, No. 158. New South Wales: Bumberry, October, identified by Lloyd (No. 452). Victoria: On living trunk of *Eucalyptus elaeophora*, F. v. M., Ararat, May (E. J. Semmens, No. 84). South Australia: On dead upright trunk of *Eucalyptus*, Adelaide Hills, July, shed spores with a large round or oval globule, 17 5 x 7 μ, identified by Lloyd (No. 672); Hindmarsh Valley, Encounter Bay, January.

316. *Hexagona rigida*, Berk. Clel. and Cheel, *loc. cit.*, No. 162. Queensland: Stradbroke Island, September, identified by Lloyd (No. 594).

317. *Hexagona tenuis*, Hook. Clel. and Cheel, *loc. cit.*, No. 159. New South Wales: National Park, May; Myall Lakes, May (thickish form).

318. *Hexagona tenuis*, var. *pulchella*, Lev. Small pored form of *H. tenuis*. New South Wales: Dorrigo, January.

319. *Hexagona tenuis*, var. *cervino-plumbea*, Jungh. Northern Territory: Darwin, April (Dr. L. Jones), identified by Lloyd (No. 321).

320. *Hexagona similis*, Berk. Clel. and Cheel, *loc. cit.*, No. 163. Queensland: Bunya Mountains, October, identified by Lloyd (Nos. 592, 593).

321. *Polyporus (Hexagona) decipiens*, Berk. Clel. and Cheel, *loc. cit.*, No. 147. New South Wales: On dead tree, Taronga Park, Sydney, June.

TRAMETES.

322. *Trametes lilacino-gilva*, Berk. Clel. and Cheel, *loc. cit.*, No. 90. New South Wales: Comboyne, September; Bullahdelah, August; Bumberry, October; National Park, May. Western Australia: Kalgoorlie. South Australia: Kuitpo, May.

323. *Trametes cervina*, Pers. Syn., *T. mollis*, Fr., in Lloyd's opinion. New South Wales: Malanganee, August, identified by Lloyd (No. 402), who says these specimens are "the same thin form as from Brazil, a little different from our (*i.e.*, the U.S.A.) plant. This form is a better *Polystictus*." Queensland: Bunya Mountains, October, identified by Lloyd (No. 632), spores 10·5 x 3·6 μ.

324 (iii., 196). *Trametes protea*, Berk. Queensland: Enoggera, September; Imbil, near Gympie, August. New South Wales: Kendall, August.

325 (iii., 195). *Trametes lactinea*, Berk. New South Wales: Bullahdelah, August. Queensland: Fraser Island (Capt. S. A. White).

326. *Trametes floccosa*, Bres. Northern Territory: Darwin, April (Dr. L. Jones), numerous elongated very pale-brownish spores, 12 to 14·2 x 5 μ, rather like those of *P. ochroleucus*, identified by Lloyd (No. 315), who says (Letter 67, Note 664) that our specimens are darker as regards surface and context colours than the Ceylon ones, but have the same texture, pores, and spores.

327. *Trametes picta*, Berk. and Br. Cooke, Handb. Austr. Fungi, No. 843 (Queensland). Queensland: Bribie Island, September, on fallen wood, identified by Lloyd (No. 496).

328. *Trametes Muelleri*, Berk. Cooke, Handb. Austr. Fungi, No. 842 (Queensland, New South Wales, Victoria). Queensland: Enoggera, September, identified by Lloyd (No. 607). We cannot make out any essential specific differences between our specimens of *T. picta* and *T. Muelleri*.

Daedalea.

329. *Daedalea gibbosa*, Pers. (as *Trametes*). We have specimens from New South Wales identified as above by Lloyd (No. 481), shed spores white, elongated, oblique, 7 to 8·5 x 3 μ.

THELEPHORACEAE.

Thelephora.

330 (iii, 209). *Thelephora terrestris*, Ehr. South Australia: Under *Pinus insignis*, Dougl., equal *P. radiata*, D. Don, Kuitpo, May, spores brown, knobby, 9·5 x 7·8 μ.

Asterostroma.

331. *Asterostroma persimile*, Wakefield. New South Wales. Specimens have been identified by Miss Wakefield through C. G. Lloyd. In her letter to Mr. Lloyd, Miss Wakefield says that the Australian plants differ in microscopical details from the type, and that she was at first in doubt whether to refer them to her own species or to hold them as different, but afterwards concluded that they were a variation of the species. New South Wales: Neutral Bay, Sydney, September and October, star-shaped bodies pale brown, rays 5, each 43 to 52 x 3·5 μ, spores warty tuberculose, 5·2 to 7 μ (associated with a yellow *Corticium* and *Stereum membranaceum*); Katoomba, on fallen logs, December, rays up to 42 x 3·4 μ, forming a felt (Lloyd, No. 253); Tuggerah, October, friable, spores irregular, whitish, 7 μ (Lloyd, No. 254).

Phlebia.

332. *Phlebia reflexa*, Berk. Lloyd considers that the following are probably synonyms:—*P. (Merulius) strigoso-zonatum* (Schweinitz); *P. hispidula*, Berk.; *Auricularia Butleri*, Massee; *A. sordiscens*, Ces.; and *Stereum lugubre*, Cooke (Letter 46, p. 6). Following Lloyd's suggestion, we place the genus in the Thelephoraceae. New South Wales: Berry, October, when moist soft and subgelatinous, hymenium much wrinkled into irregular folds pruinose with the spores, colour varying from different tints of brown to yellow-brown and purple-brown, not unlike the colours of a bruise, the growing edge when moist whitish from mycelial threads, hymenium drying blackish, reflexed surface dark brown, somewhat zoned, edge whitish, basidia tetrasporous, spores 6·2 to 7 x 3·5 μ; Milson Island, Hawkesbury River, February, identified by Lloyd (No. 149), and June; Hill Top, October, identified by Lloyd (No. 72), shed spores white, sausage-shaped with an oblique apiculus, 7 to 8·5 x 3·5 μ; Sydney, April and December; Lisarow, June and August; Kew, October. South Australia: Mount Lofty, April; National Park, June and August.

STEREUM.

333 (iii., 211). *Stereum caperatum*, Berk. and M. New South Wales: Bullahdelah, August, cladoderris form with lateral stem; Dorrigo, January; Kangaroo Valley, June, approaching *Cladoderris*, lateral stem (Lloyd 548). Fiji: Mrs. Lucas, lateral and central-stemmed specimens (Lloyd, 574; "intermediate between *Stereum* and *Cladoderris*").

334 (iii., 212). *Stereum elegans*, Meyer. In his monograph on the Stipitate Stereums, Lloyd divides his Section 4 into two divisions, *viz.*, those growing on the ground and those on wood. In the former occur *S. elegans*, densely caespitose and imbricate, often forming rosettes, and *S. nitidulum*, with a mesopodial stipe and rooting base. We have recorded the latter for Terrigal, New South Wales (Proc. Linn. Soc. N.S. Wales, xli., 1916), the identification having been made by C. G. Lloyd. We find, however, that single individuals of *S. elegans* (*e.g.*, amongst our Mount Irvine specimens) may show a rooting base and be indistinguishable from our example of *S. nitidulum*. As regards those growing on wood, *S. pergamaneum*, which we have recorded on Lloyd's identification for Pittwater, New South Wales, is like *S. nitidulum*, but grows on rotten wood and has no rooting base, whilst *S. Miquelianum* is similar but thinner, more slender and delicate, and was originally described as growing on branches. Lloyd has identified for us as this species, specimens growing on an Eucalyptus trunk at National Park, South Australia. In the same locality, typical *S. elegans* is present, forming extensive rosettes on the ground near the bases of Eucalypts, and often associated with the base of the stem or near superficial roots. We therefore think it possible that these three species—*S. pergamaneum*, *S. nitidulum*, and *S. Miquelianum*—which we have recorded or now record for Australia, may really belong to *S. elegans*, the records indicating unusual forms or sites of growth. New South Wales: Bullahdelah, August. Victoria: Craigie, June (E. J. Semmens, Nos. 55, 56). South Australia: Mount Lofty, April, June, July; National Park, April (near fallen wood), August. Spores 5 to 6 x 3.5 to 4 μ.

335 (iii., 219). *Stereum membranaceum*, Fr. Brown, rough setae, narrow clavate to acuminate, 85 to 240 x 9 to 19 μ. New South Wales: Bullahdelah, August. South Australia: Mount Lofty, May, June; Kuitpo, May.

336 (iii., 218). *Stereum illudens*, Berk. In the Milson Island specimens there are numerous rough subclavate setae projecting only slightly above the hymenium, but we have been unable to pick up any in the Bumberry and South Australian specimens. New South Wales: Milson Island, Hawkesbury River, August, setae, 17 x 3.5 μ, 31 to 35 x 3·5 μ; The Rock, July; Bumberry, September (Lloyd, 406). Victoria: Ararat, July (E. J. Semmens, No. 135). South Australia: Mount Lofty, May (spores 9 x 4 μ), July, September; Flinders Range, Quorn, August.

337 (iii., 214). *Stereum hirsutum*, Willd. South Australia: Mount Lofty, May, June, July; Belair, June.

338 (iii., 216). *Stereum vellereum*, Berk. New South Wales: Bumberry, on *Eucalyptus tereticornis*, Sm., September, identified by Lloyd (No. 376); Narrabri, November; Hawkesbury River, June. Victoria: Ararat (E. J. Semmens, No. 136). South Australia: Cherry Gardens (Prof. Osborn); Belair, June; Mount Compass, October; Mount Lofty, June (Lloyd, No. 668) and September, spores elongated, occasionally slightly curved, 5·2 to 5·7 x 2 to 2·5 μ.

339. *Stereum purpureum*, Pers. Cooke, Handb. Austr. Fungi, No. 1018 (New South Wales, Victoria, Tasmania, South Australia, Western Australia). Queensland: Bunya Mountains, October, spores pear-shaped, 5·2 x 2·5 μ, identified by Lloyd (No. 601).

340 (iii., 217). *Stereum lobatum*, Fr. Syn., *S. fasciatum*, Sch., and when young, *S. concolor*, Jungh (Lloyd). Queensland: Imbil, August. New South Wales: Mosman, April, spores 5 to 6 x 2·2 μ; near Wauchope, February, identified by Lloyd as the form *S. concolor*, Jungh. (No. 371). We also found typical *S. lobatum* with *S. tasmanicum* on the Bunya Mountains, October.

340 (a). *Stereum tasmanicum*, Berk. Syn., *S. concolor*, Berk. (Lloyd). Queensland: Bunya Mountains, October, identified by Lloyd (No. 630). These plants are hardly distinguishable from *S. lobatum*—a little thicker, uniform in colour or with slight zoning, more velvety surface, hymenium a little less pale. Typical examples of both have been found in the one locality (Bunya Mountains). Probably there is only the one species in Australia.

341 (iii., 221). *Stereum (Hymenochaete) adustum*, Lev. Syn., (?) *S. villosum*, Lev. (Lloyd). Queensland: Imbil, August, dark-brown acuminate setae with blunt or sharp ends, 30 to 45 x 3 5 to 5 3 μ.

342. *Stereum (Hymenochaete) villosum*, Lev. Clel. and Cheel, Proc. Linn. Soc. N.S. Wales, xli., 1916, p. 864. New South Wales: Kendall, March, brown setae, 25 to 42 x 5 μ (Lloyd, No. 367); Malanganee, August; Bullahdelah, August; Kurrajong Heights, August, brown-pointed setae, 44 8 to 66 x 8 3 to 13 5 μ at base.

CLAVARIACEAE.

CLAVARIA.

343. *Clavaria cinerea*, Fr. Cotton and Wakefield, Trans. Brit. Mycol. Soc., vi., 1919, p. 178; Clel. and Cheel, Proc. Linn. Soc. N.S. Wales, xli., 1916, p. 868 (N.S. Wales). We have collected further specimens of this variable species in New South Wales, and now in South Australia. The plants vary in shape from almost simple clubs to much branching from a stout base, and though mainly greyish in colour have been noted as showing tints from pale lilac-fawn and pallid pinkish to greyish-brown; spores subspherical 7 to 8 5 μ. New South Wales: Sydney, May and December; National Park, July; South Australia: Mount Lofty, June. The greyish-brown plants figured (pl. ii., fig. 4) have unusually small spores (5 μ), even when compared with other collections from the same locality (7 to 8 5 μ). Our notes as regards these specimens are as follows:—Colour greyish, gregarious, up to 2 inches high, sometimes almost simple with acute forking and subdivision into teeth at the apices, sometimes branching from near the base, stem slightly rugose, spores subspherical, 5μ. Mount Lofty, June (Miss Fiveash, Watercolour No. 22).

TREMELLACEAE.

HIRNEOLA.

344. *Hirneola polytricha*, Mont. Clel. and Cheel, Proc. Linn. Soc. N.S. Wales, xli., 1916, p. 865. Queensland: Bunya Mountains, October. New South Wales: On *Ficus platypoda*, A. Cunn., var. *mollis*, Narrabeen, July, spores curved, 13 to 14 x 5 2 μ—some of these specimens, after cooking, were eaten by one of us (J. B. C.), but proved to be very tough and almost tasteless, and did not become properly mucilaginous; on fallen log, Wingham, November; Mummulgum, December; on dead *Ficus rubiginosa*, Desf., Cremorne, Sydney, December; Cremorne, June; on dead fallen branch of *Erythrina*, Mosman (form approaching *H. auricula-judae*); National Park, May.

345. *Hirneola auricula-judae*, L. Clel. and Cheel, *loc. cit.*, p. 865. New South Wales: Bulli Pass, November; on fallen *Ficus*, Mummulgum, December.

346. *Auricularia mesenterica*, Fr. Cook, Handb. Austr. Fungi, No. 1143 (Queensland, Western Australia). New South Wales: Casino, October (D. J. McAuliffe), identified by Lloyd; Boatharbour, near Lismore, August, identified by Lloyd (No. 411, equal *A. lobata*, Swartz.).

GASTROMYCETES.

PHALLOIDEAE.

PHALLUS.

347. *Phallus multicolor*, Berk and Br. Cooke, Handb. Austr. Fungi, No. 1178 (New South Wales and Queensland). Stem and pileus together 6 inches long. Pileus 1½ inch high, more than 1 inch broad below, conical, tapering upwards so as to be less than ½ inch broad above, irregularly crinkled-lacunose, covered with the Olive-brown (Dauthenay, pl. 299, Ton. 4) gleba, attached at its summit to the pinky-orange edge of a compressed orifice, ¼ inch broad, which opens into the stem, inner surface of pileus pinkish and rugulose, substance of pileus thin. Veil dependant, 1¼ inch long, Salmon-pink (pl. 74, Tons 1 to 3), with fine meshes, attached to the stem ½ inch from its apex. Stem attenuated below and also gradually upwards, finely lacunose, orangey-pink above shading into whitish in the volva, hollow (nearly ¼ inch in diameter), with about 3 tiers of cells in the walls. Volva irregularly globose, 2 inches high, 1½ inch broad, whitish with a tint paler than Pale Reddish Lilac (pl. 131, Ton 1) with a thick jelly-like base. Spores 3·5 x 1·8 μ. New South Wales: National Park, May, 1919 (Miss Clarke, Watercolour No. 208; Herb., J. B. C., Formalin Specimen 307). (Pl. i., fig. 1.)

JANSIA.

348. *Jansia rugosa, vide* Lloyd, Synop. of known Phalloids, 1909; Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, xlix., 1915, p. 203 (New South Wales). We have collected further specimens of this rare phalloid as follows:—Mosman, Sydney, August (near the same site as specimens previously recorded); Bradley Head, Sydney, May, 1918, spores 3·4 x 1·8 μ (Formalin Sp. 300, Miss Clarke Watercolour No. 192—here reproduced as pl. ii., fig. 1); and North Dorrigo, January, 1918, on a rotten log (Formalin Sp. 299), described at the time as follows:—Whole plant 2 inches or more in height, with a musty but not foetid smell. The volva elongated, cylindrical, ¾ inch high, splitting into three or four blunt irregular lobes. Stem and pileus 1¼ inch or considerably more in length, the basal half inch of the stem whitish with obscure polygonal markings, the rest tapering to a blunt point, gleba reddish-brown to pinkish attached along the lines of an irregular meshwork on the stem corresponding to the polygonal areas seen below. Spores rod-like, 3 x 1·5 μ.

ASEROE.

349. *Aseroe rubra*, Labill. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, xlix., 1915, p. 208. New South Wales: Kendall, December; Sydney, December.

NIDULARIACEAE.

CYATHUS.

350. *Cyathus stercorareus*, Detoni. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, l., 1916, p. 106. New South Wales: Kendall, December, spores 25 μ; Cowra, December, spores thick-walled, 14 to 19 μ. South Australia: Fullarton, Adelaide, July, spores thick-walled, spherical to oval, 18 μ, 17·8 x 14·2 μ, 30 x 25 μ, etc.

CRUCIBULUM.

351. *Crucibulum vulgare*, Tul. Clel. and Cheel, *loc. cit.*, p. 107. New South Wales: On pine cone, Moss Vale, June, spores 8 x 5 μ. Victoria: On rotting bark and on trunk of *Eucalyptus hemiphloia*, F. v. M., Craigie (E. J. Semmens, Nos. 63 and 58), spores 7·5 to 10·5 x 3·6 to 4 μ. South Australia: The Hermitage, October (Prof. Osborn), identified by Lloyd (No. 380), spores

8.5 to 12 x 4 μ; Mount Lofty, June, on wood, sporangia 870 x 700 μ, spores 7 to 7·5 x 5 μ, and on manure by roadside, spores 10·7 to 12·5 μ, occasionally 21 x 4·5 μ, identified by Lloyd (No. 652).

LYCOPERDACEAE.

PODAXON.

352. *Podaxon aegyptiacum*, Mont. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales. New South Wales: 20 miles east of Broken Hill, April, spores elliptical, dark bronze-brown, 13 to 13·8 x 9 to 10 μ. South Australia: Oodnadatta (Prof. Osborn), spores dark purple, 9 to 12 x 8 to 10·4 μ.

353. *Podaxon Muelleri*, Henning. Lloyd, Lycop. of Austr., p. 5. We have a specimen collected at Kurrawang, Western Australia, by Mrs. A. F. Cleland in 1918. Spores near subspherical, yellowish, 10·5 to 12 x 8·5 to 10·4 μ.

354. *Podaxon anomalum*, Lloyd, Mycol. Notes, No. 64, September, 1920, p. 992, fig. 1776. We sent C. G. Lloyd half of the single specimen collected, and he has kindly described and figured it as above (No. 549). Unfortunately we have not noted the locality, which was probably the Murray River area between the North-west Bend and Overland Corner, but may have been Western New South Wales. Lloyd in his notes says that this really belongs to a new genus, intermediate between *Podaxon* and *Secotium*. "It is a *Secotium* in general appearance, but *Secotium* does not have powdery gleba. The dehiscence cannot be told surely from the specimen, but the peridium is soft and fragile, and seems to flake off in the manner that *Cauloglossum* is said to dehisce. This is entirely at variance with any *Podaxon*. The columella, thick at the base, rapidly tapers and does not reach the apex of the peridium. This is another feature of which I know no similar case. The gleba is light brown, floccose, powdery. The microscope resolves it into pale yellow, globose or elliptical, smooth spores, 10 to 12 x 12 to 14 μ, which are mixed with abundant hyaline hyphal fragments, apparently the remains of the basidia. It does not have true capillitium. We place it provisionally in *Podaxon* on account of the gleba nature, and *Podaxon* is one of the few puff-ball genera in which basidial remains are found in the gleba."—Lloyd. We note that the spores are thick-walled.

SECOTIUM.

355. *Secotium melanosporum*, Berk. Cooke, Handb. Austr. Fungi, No. 1220 (Western Australia). We have collected this rare species in one locality only, *viz.*, Monarto South, in South Australia, though in several places within a mile of each other. The identification has been confirmed by Lloyd (No. 734). Lloyd, in his Lycoperdaceae of Australia, states that the only specimen known then was the type collected by Drummond in the Swan River Settlement "over sixty years ago." We have described our specimens as follows:—At first conico-campanulate, the pileus then expanding and convex up to 2½ inches in diameter, bearing a general close resemblance to a common mushroom. The upper-surface pallid whitish and a little fibrously striate; the substance, up to ¾ inch thick, composed of small irregular cells, 1½ to 4 mm. in diameter, the walls pale greyish lined with olive. A fine whitish veil covers the under-surface of the cap, which when removed or ruptured shows the shrunken walls of the cells of the substance which are in places elongated in lines, suggesting the incipience of gill formation, the depth of these cells being very shallow. A thin film of tissue covers the cellular hymenial area, this being thickest over the stem. The stem itself is up to 3½ inches high and ½ inch in diameter in the middle, solid, attenuated upwards, the root rounded, slightly bulbous, pallid whitish, fibrously striate, extending through the cap to the upper-surface. The flesh turns reddish when cut. Hymenial area, Bistre (pl. 29). Spores purplish-brown, oval with an

apiculus, 7 to 9 x 5·2 to 7·5 μ. Partly buried under sand, September, 1920, May, 1921.

356. *Secotium coarctatum*, Berk. Cooke, Handb. Austr. Fungi, No. 1219 (Western Australia). We came upon this species at Narrabri in June, 1919, and the identification has been confirmed by C. G. Lloyd (No. 528). Lloyd points out that this is probably the first collection made since the type was found and that the specimens agree exactly with the type and Berkeley's figure of it. We described the specimens when fresh as follows:—Whitish, somewhat quadrilateral but broader (½ inch +) above than below (½ inch —); stem short, whitish, continued to the top of the pileus; substance pallid greyish-brown; spores whitish, smooth, 5·2 to 7 μ; a peculiar strong fragrant smell (the type is described as strong-scented).

CHLAMYDOPUS.

357. *Chlamydopus Meyenianus*, Berk. Clel. and Cheel, *loc. cit.*, p. 109. South Australia: Miller Creek, between Mount Eba and North-South Railway Line, August, spores yellow-brown, spherical, finely rough, 6·4 to 7·5 μ (T. D. Campbell).

PHELLORINA.

358. *Phellorina Delestrei*, Dur. and Mont. Lloyd, Lycoperd. of Australia, p. 10, pl. 27; Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, l., 1916, p. 110. We have a further Australian specimen obtained by Mr. T. D. Campbell at Miller Creek, between Mount Eba and the North-South Line, in Central Australia, August, 1921. Our plant has a conically rooting stem, surrounded by compacted sand, extending 2 inches below the ground surface; spores round or a little irregular, yellow-brown, smooth, 6·4 to 7 μ.

359. *Phellorina australis*, Berk. Syn., *Xylopodium australe*, Berk. Lloyd, Lycop. of Austr., p. 11, fig. 7. We have received, through Prof. Osborn, a specimen collected by Capt. S. A. White in Central Australia. The plant is somewhat turbinate, 1½ inch high and 1¼ inch wide, pallid, somewhat irregularly rugose above and contracted into a short stem below which is surrounded by a collar, probably the remains of the volva. Spores rough, 5 to 6 μ. Colour of spore mass a little lighter than Dresden Brown (pl. xv.). Lloyd describes his specimen as having a bright ochraceous gleba, but in our specimen the colour is decidedly darker.

360. *Phellorina strobilina*, Kalch. Syn., *Areolaria strobilina*, Kalch. Cooke, Handb. Austr. Fungi, No. 1318, Queensland; *Xylopodium ochroleucum*, Cke. and Massee, Cooke, *loc. cit.*, No. 1324, Queensland. We have a small specimen, of which the locality has not been noted but is probably Central South Australia, which agrees exactly with the plate (27, fig. 3) given by Lloyd in his Lycoperdaceae of Australia. The peridium, 1 inch in diameter and ¾ inch high, is broken up into thick angular scales. The stalk is 2½ inches long, slightly curved, attenuated upwards, ¼ inch below and three-sixteenths inch thick above, clothed with adpressed scales, their free edges upwards. The spores are pale brown, warty, rather irregular, 5 to 7 μ. The following have been identified for us as *Phellorina strobilina* by C. G. Lloyd. We have collected these large specimens on four occasions in the same locality, twice evidently from the same mycelium, in May, September, and October, after heavy rain. None of our specimens were mature. The largest measured 11¾ inches high, of which 6½ inches were above ground. The peridium was oval, 4½ inches high and 3 inches wide, white, covered with large peeling ligulate scales, adherent below at various levels and recurved and reflexed above where they have split off. The peridial wall was ⅛ inch thick, white, surrounding the gleba mass, which was slightly irregularly

oval, 3¾ inches x 2¾ inches, white and soft. The woody stem was 7 inches long, a little constricted at the ground level (diameter, ⅞ inch), 1¼ inch thick below the peridium, 1½ inch below the ground level, with a thick hard crust, brownish tinted below the cuticle in the upper part, covered above ground with firm ligulate scales, firmer than on the peridium, white inside and moderately firm, solid, the lower end rounded and connected with an indefinite mass of mycelium spreading through the sand. Moderately strong smell. Younger specimens show some points of difference. From one-third to one-quarter of the plant is below the ground. The peridium is at first clavate. The ligulate scales are in some adherent above by a broad base, sometimes an inch long, hanging down and overlapping, contracting from the base to a sharp apex, up to 1½ inch long. The scales on the stem appear more as coarse thick bands of fibrils. The wall of the peridium is ⅛ inch to ¼ inch thick. Sphores spherical, nearly smooth, 6·5 to occasionally 8 μ; some short threads, 3·2 to 4·8 μ thick, occasionally apparently septate. Monarto South, South Australia.

BATTAREA.

361. *Battarea phalloides*, var. *Stevenii*, Fr. Clel. and Cheel, *loc. cit.*, p. 111. South Australia: Monarto South, May, volva of two layers, an outer thin crust, darkish externally, and an inner thicker more fibrous layer; Murray Bridge, July (Mr. Ashby); Nankeri, on sandy rise in fallow, May (Prof. Osborn). Western Australia: Kurrawang (Mrs. A. F. Cleland).

POLYSACCUM.

362. *Polysaccum pisocarpium*, var. *crassipes*, D. Cand. Clel. and Cheel, *loc. cit.*, p. 113. Queensland: Stradbroke Island, September. New South Wales: Eulah Creek, Narrabri, June, stem 4 inches long, 1¼ inch thick, spores shaggy-warty, 9 to 10·5 μ. South Australia: Mount Lofty, July, up to 4½ inches high, often with several "heads"; Beltana, August, spores shaggy, 8 to 11 μ.

363. *Polysaccum pisocarpium* (variety not identified). New South Wales: Bullahdelah, August.

SCLERODERMA.

364. *Scleroderma verrucosum*, Bull. Clel. and Cheel, *loc. cit.*, p. 116. New South Wales: National Park, May, spores shaggy, 10·5 to 12 μ; Sydney, May, December. South Australia: Our record (in the above paper) of this species for South Australia is doubtful, the plants being immature and perhaps really *S. flavidum*. We have not recently found any specimens.

365. *Scleroderma flavidum*, Ellis. Lloyd, The Lycop. of Austr., etc., p. 14. Clel. and Cheel, *loc. cit.*, p. 114. New South Wales: Kendall, March and December (latter specimens containing a nest of small ants). South Australia: Murray River, unopened, doubtfully this species, spores dark brown, very shaggy, 12 to 15·5 μ, usually 14 μ; locality not noted, spores densely echinulate, 13 to 17·5 μ; Mount Lofty, July, spores shaggy, 7·2 to 10·7 μ; Kuitpo, May, spores densely echinulate, 11 to 14·5 μ, confirmed by Lloyd (No. 780). Victoria: Ararat, May (E. J. Semmens, No. 91).

366. *Scleroderma flavidum*, var. *fenestratum*, nov. var. In our description of some specimens of *Scleroderma* found in the Pilliga Scrub (Bot. of Pilliga Scrub, Bull. 14, For. Comm. N.S. Wales, 1920, p. 19), we refer to the peridium being supported on a fenestrated stem or root, sometimes several inches long. As these plants grow in sandy soil, this probably enables the peridium to project above the shifting sand. The fenestrated portion consists of broad, rugose, often flattened, intercommunicating strands of mycelium, tailing off below into

mycelial threads. To distinguish this form, that we have now frequently met with, we propose the above varietal name. This form is also of interest as, in one case, having manifested parasitic features of some economic importance.

Victoria: In 1917, Mr. C. C. Brittlebank, of the Department of Agriculture of that State, sent us specimens of a *Scleroderma,* which we now refer to this variety, found at Dandenong in June, which had killed off a number of rose trees. He says, "There is not the slightest doubt as to the parasitic nature, as the mycelium was traced right through the outer coverings into the cambium and underlying tissues." The specimen sent was unopened with a thick peridium supported on an irregular reticulated mass of thick mycelial strands forming a mass larger than the peridium itself, spores shaggy, acicular, dark brownish, 12 to 15·5 μ, hyphae 7 μ thick.

South Australia: Eagle on Hill, June, spores densely echinulate, 11 μ; an unexpanded plant from near Overland Corner (this locality is doubtful) is probably also this variety—the thick-walled peridium is supported on a very irregularly rugose somewhat flattened stem without fenestrations, 3 inches long and ¾ inch thick in places, spores densely echinulate, 12·2 to 15·5 μ; an old specimen from Overland Corner, December, in which the peridium has burst into stellate, sometimes subdivided lobes, supported by a short thick stem, ¾ inch long and ½ inch broad, attached below by a constricted neck to a mass of irregularly to nobby, somewhat flattened, not definitely fenestrated compacted mycelium forming a root below ground, 1 inch long and broad, spores "smooth" (probably the result of weathering, the specimen having been long exposed), spherical, yellow-brown, 5·2 μ; Eagle on Hill, another collection, identified as *S. flavidum* by Lloyd (No. 692), peridium splitting into up to 8 lobes, root 3 inches long x 1¼ inch wide, dense but spongy above, passing below into interlacing mycelial strands, spores mulberry-like, 9 to 12 μ.

GEASTER.

367. *Geaster fornicatus,* Hudson. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, xlix., 1915, p. 224. New South Wales: In brush, Malanganee, August, spores warty, 3·5 to 4 μ, confirmed by Lloyd (No. 419).

MYCENASTRUM.

368. *Mycenastrum corium,* (Guersent) Desv. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, L., 1916, p. 116. South Australia: Glen Osmond, December, spores rough, 10·7 μ; Morphett Vale, October; Berri, January, spores shaggy, 12·5 to 14 μ. New South Wales: Eulah Creek, Narrabri, June, spores slightly rough, 10·5 to 12 μ.

CATASTOMA.

369. *Catastoma pedicellatum,* Morgan. Spores dark brown, coarsely warted and mulberry-like, 6·8 to 8·5 μ. Pedicels 17 to 26 μ, tapering, sometimes curved. Capillitium barely tinted to brown, occasionally branching, noted as septate in one collection, 2·5 to 3·5 μ thick. New South Wales: Sussex Island, Clarence River, October (identified by Lloyd); Narrabri, June, spores with a septum near the head (Lloyd 527); Yanco area, November. South Australia: Port Elliot, August.

370. *Catastoma anomalum,* Massee. Clel. and Cheel, *loc. cit.,* p. 117. New South Wales: Hawkesbury River, January, March; Dubbo, June, spores spherical to oval, finely rough to smooth, 4·2 to 5 μ (Lloyd 78).

371. *Catastoma hyalothrix,* Cooke. New South Wales: Milson Island,

Hawkesbury River, February, spores smooth, 4 μ (this size seems unduly small), identified by Lloyd (No. 139).

BOVISTELLA.

372. *Bovistella aspera.* Clel. and Cheel, *loc. cit.*, p. 117. Spores 3·2 to 6·5 μ, pedicels 8·5 to 19 μ. New South Wales: Near Barellan, August; Junee, October; Blayney, December; Milson Island, Hawkesbury River, October. Victoria: Ararat, May (E. J. Semmens, Nos. 97, 98, 100). South Australia: Beltana, August, capillitium coloured; Monarto South, September.

373. *Bovistella australasiana.* Clel. and Cheel, *loc. cit.*, p. 118. Spores smooth, 4·2 μ. New South Wales: Sydney, June, pedicels 17 μ, capillitium 3·5 μ; Murwillumbah, April, pedicels, 7 to 10·4 μ (Lloyd 138).

LYCOPERDON.

374. *Lycoperdon pusillum,* Batsch. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, L., 1916, p. 120. Spores spherical to sometimes oval, 3·5 to 5 μ, usually smooth; capillitium pale brownish. New South Wales: Hawkesbury River, February; Narrabeen, March; Blue Mountains, May, spores finely tuberculately warty; Berrima, July; Murwillumbah, April; Narrabri, June; Eulah Creek, near Narrabri, November; Baan Baa, January, distinct stumps of pedicels, very rarely pedicels 14 μ long; Coolamon, May. Victoria: Ararat May (E. J. Semmens, No. 96). South Australia: Mount Lofty, April.

375. *Lycoperdon pratense,* Pers. Clel. and Cheel, *loc. cit.*, p. 121. Spores 3·2 to 5 μ; capillitium white, sometimes septate, 3·2 to 5 μ. Victoria: Ararat, May, occasional pedicels 1·5 μ long (E. J. Semmens, No. 95). South Australia: Beaumont Common, near Adelaide, June, up to 1½ inch high, the upper part laterally expanded, contracting into the stout cellular base from which a few white mycelial threads radiate, covered with slightly biscuit-coloured mealy warts, strong smell; Eagle on Hill, June; Mount Lofty, April; Kuitpo Forest, May.

376. *Lycoperdon pyriforme,* Schaeff. Clel. and Cheel, *loc. cit.*, p. 122. Queensland: Bunya Mountains, October, spores smooth, 3·5 μ, capillitium brown, 3·5 to 4 μ.

377 (iii., 232). *Lycoperdon gemmatum,* Batsch. New South Wales: Malanganee, August, spores slightly rough, 3·8 μ; Lisarow, June.

378. *Lycoperdon subincarnatum,* Peck. Clel. and Cheel, *loc. cit.*, p. 121. New South Wales: National Park, on wood, July; Lisarow, June.

CALVATIA.

379 (iii., 233). *Calvatia lilacina* (Berk.). Spores warty or only slightly rough, 3·6 to 6·5 μ. New South Wales: Sydney, April, spores warty, 5 to 7 μ; Port Macquarie, January, capillitium 5 μ thick (Lloyd, 488—"unusual in the surface breaking up areolately into plates"). South Australia: Eagle on Hill, April; Victor Harbour, November (J. K. Samuel) and January (breaking up areolately into plates); Flinders Range, Quorn, August.

380. *Calvatia craniiformis,* Schw. Syn., *C. Gardneri,* Berk. Clel. and Cheel, *loc. cit.*, p. 123. Lloyd, as a result of an examination of a number of Australian specimens, has come to the conclusion that *C. Gardneri* is conspecific with *C. craniiformis.* Spores smooth, 3·4 to 5 μ; capillitium brownish, 3·5 μ. New South Wales: Sydney, April (under *Lantana,* Lloyd, 484) and June (Lloyd, 151); near Wauchope, February, elongated pear-shaped in form.

MITREMYCES.

381. *Mitremyces fuscus*, Berk. Clel. and Cheel, *loc. cit.*, p. 125. New South Wales: On clay bank, Cambewarra Mountain, Nowra, June, spores whitish; warty, 14 x 8·5 μ. South Australia: On clay bank and on flat ground, Mount Lofty, July, spores whitish with slight whitish clay tint, elliptical to a little irregular, finely rough, 11 to 12·5 and occasionally 14 x 7·5 to 8 μ.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. *Phallus multicolor*, B. and Br., and section of stem, ⅔ natural size.
" 2. *Cantharellus cinereus*, var. *australis*, var. nov., with section, natural size.
" 3. *Cantharellus triangularis*, n. sp., and section, enlarged 1½ times.
" 4. *Boletus subglobosus*, n. sp., with section, natural size.
" 5. *Marasmius subinstitius*, n. sp., natural size on leaf, with pileus, underside of pileus, and section enlarged 2½ times.
" 6. *Amanitopsis subvaginatus*, n. sp., with section, cross-section of gills, and spore, natural size (except spore).
" 7. *Marasmius rugoso-elegans*, n. sp., with section, underside of pileus, and spore (?), natural size (except the spore?).

Water-colours all by Miss Phyllis Clarke, Sydney.

PLATE II.

Fig. 1. *Jansia rugosa*, enlarged twice.
" 2. *Polyporus basilapiloides*, MacAlp. and Tepper, with upper-surface of pileus, two-thirds natural size.
" 3. *Mycena epipterygia*, Scop., two-thirds natural size.
" 4. *Clavaria cinerea*, Fr., two-thirds natural size.

Water-colours of Figs. 1, 3, and 4 by Miss Phyllis Clarke; and of Fig. 2 by Miss Fiveash, Adelaide.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.
No. 5.—THE LIZARDS.

By JOAN B. PROCTOR, F.Z.S., British Museum (Nat. Hist.).

[Read April 12, 1923.]

(Communicated by Professor F. Wood Jones.)

Very little is known about the island fauna of this region, and the present collection, which was made chiefly in Nuyts Archipelago and the Investigator Group, is therefore interesting. Many of the mainland species which one would have expected to find in the islands were not obtained, and probably do not occur. Examples of twelve species were collected, several of which are extremely rare, and one of which is new. The latter I have named after Prof. Wood Jones, who has kindly presented the whole collection to the British Museum.

For the sake of brevity, the only references given are:—(1) The original description of the species. (2) Boulenger's, in his Catalogue of Lizards.[1] (3) Zietz's Catalogue of Australian Lizards,[2] to which useful work the reader is referred for information on the distribution and synonomy of each species and the bibliography of the subject.

GECKONIDAE.

1. *Phyllodactylus marmoratus.* Gray, Cat., 1845, p. 149; Boulenger, B.M. Cat. Liz., vol. i., p. 88, pl. vii., fig. 6; Zietz, Cat. Austr. Liz., p. 185.

Two specimens from South Neptune Island and five from Black Rock. Occurs also on Franklin Island, Pearson Islands, and Price Island. Already known to inhabit Kangaroo Island; it has a wide distribution on the mainland.

PYGOPODIDAE.

2. *Delma fraseri.* Gray, Zool. Misc., 1831, p. 14; Boulenger, *op. c.*, vol. i., p. 243; Zietz, *op. c.*, p. 192.

Three specimens from St. Francis Island. Known from all parts of Australia.

3. *Lialis burtoni.* Gray, P.Z.S., 1834, p. 134; Boulenger, *op. c.*, vol. i., p. 247; Zietz, *op. c.*, p. 193.

One specimen from St. Francis Island, beautifully marked[3] with five dark longitudinal bands above; six cream-coloured bands beneath, with a series of fine cream-coloured speckles between each. Scales in 21 rows.

Known from all parts of Australia and New Guinea.

AGAMIDAE.

4. *Amphibolurus decresii.* Dum. and Bibr., Erp. Gen., 1837, vol. iv., p. 472, pl. xli., fig 1; Boulenger, *op. c.*, vol. i., p. 385; Zietz, *op. c.*, p. 196.

A male and female of this very rare species were caught on Pearson Island. The British Museum possesses but two specimens, both males.

The new male has longer legs, which, when adpressed, reach to between the eye and the nostril, and a longer tail, more than twice the length of head

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(1) Brit. Mus. Cat. Liz., 1885-87.

(2) Rec. S. Austr. Mus., i. (3), 1920.

(3) Brit. Mus. Cat., var. E.

and body. Its colouration is striking; almost black above with a dorsó-lateral and lateral series of golden elongated spots; throat golden reticulated with bluish-grey; a large black area on chest, continuing in a point almost to the vent, and produced along the under-surfaces of the arms. The female is beautifully variegated, with a light salmon-pink on dark brown, with series of dorso-lateral and lateral spots, or broken stripes as in the male, but continuing in bright longitudinal bands down the tail; throat marbled with grey, the rest of the lower surfaces immaculate cream colour. [The species is very abundant on Pearson Island, but has been seen on no other islands.—F. W. J.]

SCINCIDAE.

5. *Egernia whitii.* Lacep., Ann. Mus. Paris, iv., 1804, p. 192; Boulenger, *op. c.*, vol. iii., p. 135; Zietz, *op. c.*, p. 203.

Three specimens from Greenly Island and one from Franklin Island.

All are handsomely marked, and those from Greenly Island had evidently the under-surfaces brick-red in life, with blue throats marbled with black. The head-shields are extremely variable, particularly the frontal, which may be in contact with the frontonasal, or widely separated from it by the internasals.

The British Museum has a specimen from Kangaroo Island, the nearest locality to those recorded above. The species has a very wide distribution.

6. *Lygosoma (Liolepisma) entrecasteauxii.* Dum. and Bibr., Erp. Gen., v., 1839, p. 717; Boulenger, *op. c.*, p. 276; Zeitz, *op. c.*, p. 203.

One specimen from Pearson Island.

This charming skink was until recently only known from Tasmania. The British Museum has received no specimens since 1887, when the Catalogue was published.

The new specimen is particularly well marked, being olive, with a black vertebral streak flanked on each side by a series of round black spots. It has also a light-spotted dark dorso-lateral band edged by a light and a dark lateral streak. The tail is annulated with small olive and black ocelli; the lips and lower parts are turquoise-blue. The dorsal scales are tricarinate.

7. Lygosoma (Homolepida) wood-jonesii, n. sp.

Material.—An adult female and two half-grown specimens.

Locality.—St. Francis Island.

Diagnosis.—Allied to the Western Australian *L. gastrostigma*, Blgr.,[4] from which it differs chiefly in having smaller eye and ear openings, a shorter interparietal shield, more widely expanded median subcaudals, 28 instead of 26 rows of scales, and in colouration.

Description.—Body very elongate; the distance between snout-tip and fore limb goes twice and two-thirds in the distance between axilla and groin in the adult, just over twice in the half-grown specimens. Tail about as long as head and body.

Snout moderate; obtusely pointed. Eye small, about as deep as the sixth upper labial; lower eyelid scaly. Nostril pierced in a single nasal which forms a suture with its fellow; a vertical groove behind the nostril, as in *L. branchiale* and *L. gastrostigma.* Ear opening very small, with one lobe anteriorly. Frontonasal broader than long, forming a suture with the frontal; praefrontals separated from each other, sometimes widely; frontal two-thirds broad as long, longer than its distance from the snout-tip, in contact with first and second supraoculars; frontoparietals two-thirds as long as interparietal, which separates the parietals. Loreals small, square; 2 praeoculars, 3 supraoculars; 6 superciliaries; 2 series of suboculars (the inner of minute scales),

(4) Boulenger, Proc. Zool. Soc., 1898, p. 222, pl. lvii.

the outer interrupted by the sixth upper labial, 8 upper and 6 lower labials, 3 pairs of nuchals, 28 smooth scales round the middle of the body, the two median rows largest. No enlarged praeanals. Median subcaudal plates strongly dilated transversely, being more than half the width of under-surface of tail, and twice the width of bordering scale-rows.[5]

Limbs short; the length of the hind limbs equals the distance between the fore limb and anterior corner of eye or more (to second labial); third and fourth toes equal, or third a little longer, 12 or 13 lamellae beneath the fourth toe, 10 or 11 beneath the third finger.

Upper-surfaces dark greyish-brown, uniform, each scale narrowly edged with black. Lighter beneath, each scale also dark edged. Traces of rust-colour about the anal region of the adult female.

8. *Lygosoma (Hemiergis) peronii.* Fitz., Neue Classif. Rept., 1826, p. 53; Boulenger, *op. c.*, vol. iii., p. 326; Zietz, *op. c.*, p. 215.

Specimens from Streaky Bay (mainland), South Neptune Island, Black Rock, St. Francis Island, Pearson Island, Price Island, and Flinders Island.

Two specimens (Streaky Bay and St. Francis Island) show the typical form of colouration, in which the dorsal area is uniform or speckled with black. The rest are strongly marked with a vertebral paired series of black dots, which may be confluent into a single vertebral streak. So striking is this character, that if it were not for the exceptions mentioned I should be inclined to consider that these insular specimens belonged to a distinct race.

Slight variations of form occur, one specimen being unusually elongate, the distance from axilla to groin being three times that from fore limb to snout-tip.

9. *L. (Hemiergis) decresiense.* Fitz., Neue Classif. Rept., 1826, p. 53; Boulenger, *op. c.*, vol. iii., p. 327; Zietz, *op. c.*, p. 216.

One specimen of this rare skink from Flinders Island. The British Museum has only four specimens, one of which is from Kangaroo Island.

10. *L. (Rhodoma) frosti.* *Rhodoma tetradactyla*, Lucas and Frost, Proc. Roy. Soc. Vict. (n. ser.), vol. vii., 1895, p. 268, and Rep. Horn Expd., ii., 1896, p. 142, pl. xii., fig. 3; [6] *L. frosti*, Zietz, *op. c.*, p. 217.

Specimens from Streaky Bay (mainland), Flinders Island, and South Neptune Island.

This extremely rare and interesting skink was first discovered in Central Australia. The only two specimens in the British Museum are from Murray River, South Australia.

The digits of the Southern specimens compared with the plate of the type of *L. tetradactyla*, appear to be longer and more slender, particularly the third finger and toe. It is possible that the two may be distinct varieties or geographical races.

11. *L. (Rhodoma) punctatovittatum.* Gunther, Ann. Mag. Nat. Hist. (3), vol. xx., 1867, p. 47; Boulenger, *op. c.*, vol. iii., p. 335; Zietz., *op. c.*, p. 216.

One specimen of this extremely rare skink from Flinders Island. The British Museum has only the type-specimen, received in 1866; the new individual agrees with this in every detail.

12. *Ablepharus lineo-ocellata.* Dum. and Bibr., Erp. Gen., vol. v., p. 817; Boulenger, *op. c.*, vol. iii., p. 348; Zietz, *op. c.*, p. 220.

One very young specimen from St. Francis Island.

The dorsal ocelli are well marked.

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(5) In *L. gastrostigma* these plates are but one-third the width of the tail, and once and a half times the width of the bordering scales; moreover, they are scale-shaped, whereas in *L. wood-jonesii* they are shape of the ventrals of a snake.

(6) Specific name preoccupied.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 6.—THE DIDELPHIAN MAMMALS.

By Frederic Wood Jones, D.Sc., F.L.S.,
Professor of Anatomy in the University of Adelaide.

[Read April 12, 1923.].

Hitherto, no member of the didactylous section of the marsupials has been found on any of the islands, and probably there is no hope that any of the small, rare, carnivorous forms may yet find island sanctuary in Nuyts Archipelago or the Investigator Group. It is not remarkable that the smaller waterless islands should lack the little carnivores; but it is rather surprising that they should be absent from the larger land masses. In this connection it is worth noting that even Kangaroo Island holds out little prospect of being the home of any of the rare didactyla. Mr. May, the ranger of Flinders Chase, an observant man and a life-long trapper, only remembers to have seen on one occasion, and that when a small boy, an animal which appears to have been *Dasyurus viverrinus.* I know of no record of any species of *Sminthopsis* or *Phascogale* from Kangaroo Island nor from any of the islands of the Bight.

Of the syndactylous section, certain bandicoots and wallabies have already been obtained and studied, and those that have so far been dealt with have proved to be of the greatest interest.

The mammals hitherto described from the islands (present series of papers, No. 2, vol. xlvi., pp. 181-193) might possibly be said, by critics favouring such a form of argument, to be mere waifs—creatures which had come to inhabit the islands when these were already completely severed from the mainland. The possibilities of the dispersal of rats are well known, and *Leporillus jonesi* might by some be regarded as being an immigrant to the Franklin Islands. But with the wallabies the case is very different. There can hardly be an alternative to the supposition that they are part of the original mainland fauna, and that they occupied their present site when it was a portion of the southern shores of the continent. If only for this reason then the larger didelphian forms hold out the possibility of being creatures of exceptional interest. Unfortunately we are only dealing with a remnant to-day—several species have become extinct within the memory of the present generation—and of these exterminated creatures no trace whatever seems to be left, not even a skin, or a skull, remains preserved in any collection.

The Franklin Island Bandicoot.

Isoodon nauticus (Thomas, 1922).

No examples were seen during the short daytime visit to the Franklin Islands in November, 1920. The presence of a bandicoot was suspected, however, and during the first night (January 9, 1922) spent camped on the western island, it became very evident that speculations made about the fauna of an island visited only at noon are liable to rude upsets when the stay is prolonged after nightfall. When night comes on, the Franklin Islands wake up. At noon, a few shallow depressions scratched at the roots of herbage may make one feel fairly confident of the presence of bandicoots; but at dusk, the hurrying

and yet unhurried little forms that run from one tuft of vegetation to another make the whole island appear alive with small animals. Some are *Leporillus jonesi* and some are bandicoots, and it is difficult at twilight to distinguish the one from the other. The main difference between the two animals from the point of view of behaviour is that the bandicoots seem to be almost fearless, whilst the rats are extremely shy. On several occasions bandicoots came boldly to the hands of members of the party who offered them such delicacies as bread and jam, and throughout the night they ran freely about the camp regardless of its human occupants. Although they appear to live on terms of perfect goodwill with the *Leporillus*, they are, like all bandicoots, excessively pugnacious among themselves; and most of those seen or caught had ragged ears, and incomplete tails, the results, most probably, of internecine fights. Only two examples were met with in which the tail tapered to its undoubted original tip. They fight desperately when placed together in a cage; but one put into the enclosure occupied by an *Isoodon obesulus* was killed by the heavier mainland animal before it could be rescued.

For the most part they live in the thick tangles which the strands of *Tetragonia implexicoma* make around low vegetation; but on several occasions

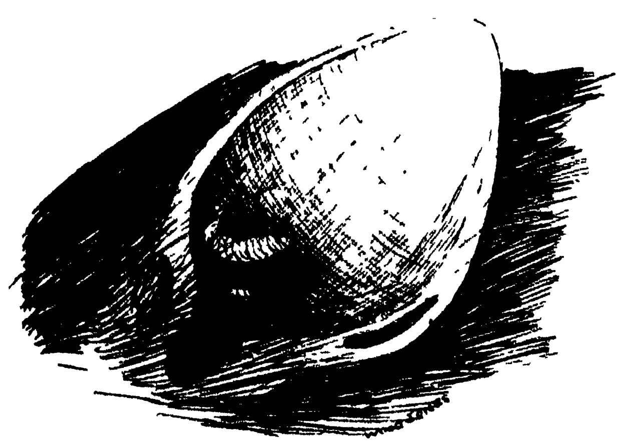

Fig. 1
Left ear of a male adult specimen of *Isoodon nauticus* Twice natural size.

they were noticed to retreat into the holes of mutton birds. They also live all over the plateau of the island in the thick clumps of vegetation of which *Nitraria schoeberi* is the main constituent. None were trapped, but some were seen on the eastern island, and there can be little doubt that it is just as abundant there as it is upon the island upon which the 1922 camp was made. Like all the bandicoots, it is omnivorous. No pregnant females or very young specimens were captured, and it is probable that the breeding season is at the same time of the year (June) as that of its mainland relatives. The males appeared to vastly outnumber the females, and in January the genital glands are in a quiescent phase. The Franklin Island bandicoot is small, lightly built, and somewhat pale. Specimens obtained in January, 1922, were sent to Mr. Oldfield Thomas, and were described by him as a new species, *Isoodon nauticus* (Ann. and Mag., Nat. Hist., Ser. 9, vol. ix., June, 1922, p. 677). The following is the description of the type specimen:—"Size markedly smaller than in the continental *obesulus*, the skull of an adult male only about 55 mm. in length, as compared with 70 or more in *obesulus*. General colour comparatively pale;

under-surface white; hands and feet with grey-brown metapodials and white digits; tail brown above, whitish below. Skull far smaller than in *obesulus*, smooth, and almost without cranial ridges, the sagittal crest obsolete, and even the two lateral thickenings of the occipital much less developed than usual. Nasals much shorter and narrower than in *obesulus*. Bullae not far from as broad as in *obesulus*, but peculiarly shortened, rather abruptly cut off behind.

Teeth small throughout. The three juxtaposed incisors, I^2-I^4, together about 3 mm. as compared with 4 5 and upwards in *obesulus*. Canines short. Secator and molars all proportionately reduced.

Dimensions of the type (measured on the spirit-specimen before skinning): Head and body, 242 mm.; tail (damaged), 103 mm. in another rather younger specimen; hind foot, 50.

Skull: Greatest length, 54 5; condylo-basal length, 53; zygomatic breadth, 25 3; nasals, 21 7 x 5 2; intertemporal breadth, 11 6; palatal length, 31; oblique diameter of bulla, 10 3; dental length, 98; front of canine to back of M^4, 20 5; diameter of secator, 2; combined length of M^{1-3}, 8 5.

To this it may be added that this little bandicoot, which is an extremely active and rather elegant little creature, is very readily distinguishable from

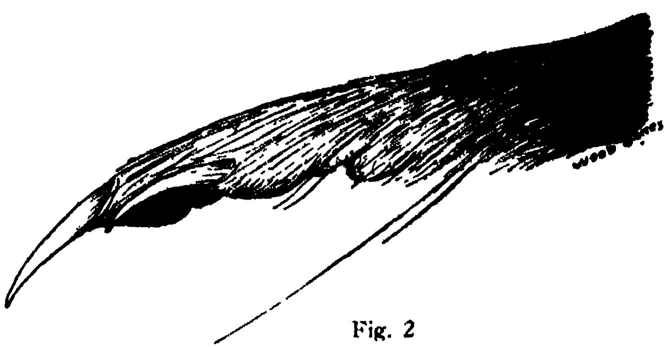

Fig. 2

Manus of *Isoodon nauticus*, showing the contrasted white of the digits, and the ulnar carpal vibrissae. Twice natural size.

I. obesulus when living examples of the two species are seen side by side. Its whiter ventral surface, and its small pale manus and pes, combined with its general light build, make it a very different looking animal from the sturdy, more compact, and darker mainland form. In the skull, as Oldfield Thomas has noted, the bullae are most distinctive, and it has been thought well to illustrate this point by scale drawings of the bulla region of an adult male *nauticus* and of a small example of *obesulus*. It will be noticed in comparing figs. 4 and 5 that the bullae of *nauticus* are short and broad as contrasted with those of *obesulus*, and that they appear to be truncated at their posterior ends. One other cranial feature is worthy of note. In *nauticus* the intertemporal constriction is relatively considerably less than in *obesulus*, the skull being distinctly less hour-glass shaped. I have attempted to illustrate this point by a method, familiar enough in anthropology but not greatly employed in the study of mammals, of superimposing the outline of one skull upon the outline of the other. Fig. 6 is so constructed that the middle point in the length of the two skulls coincides, and from the resulting diagram it will be seen that whereas the skull of *nauticus* is in general considerably smaller, the intertemporal constriction, at its minimum, varies but little in the two crania. Finally, the general roundness of the skull and lack of muscular ridges, and the absence of sagittal

and nuchal crests gives to the cranium of *nauticus* a remarkably juvenile appearance. No matter how old the animal may be, this immature appearance of the cranium is retained both by males and females.

BANDICOOTS OF OTHER ISLANDS.

It is possible that on some of the other islands there are still bandicoots living, but so far only upon St. Francis Island has an actual specimen been obtained. This example, an adult male, was caught by a dog as it escaped from some burning vegetation. In all external and cranial characters it is a typical *Isoodon nauticus*.

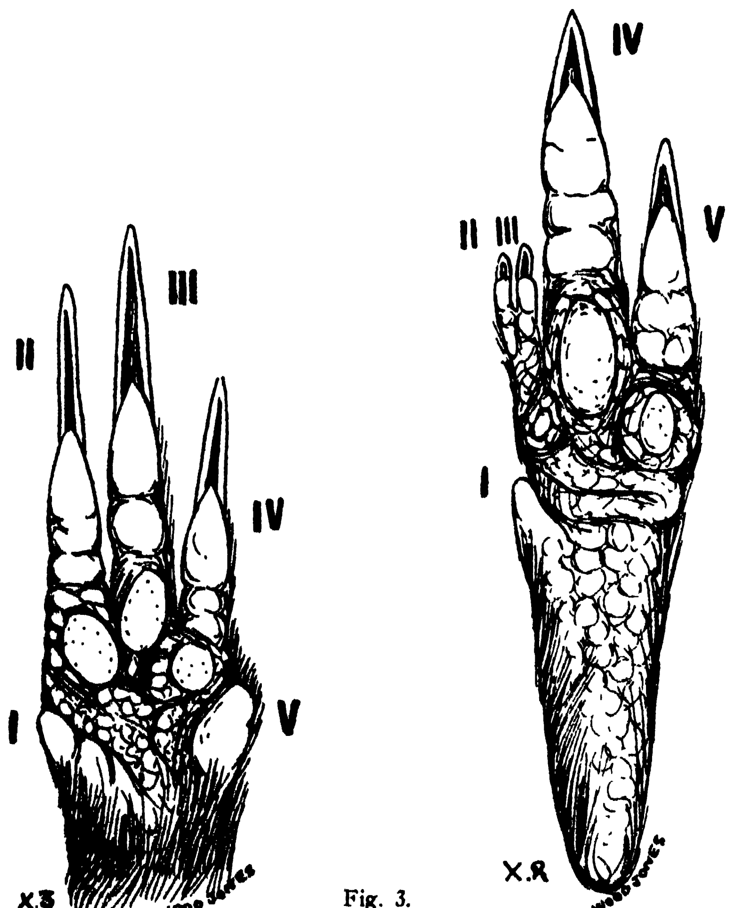

Fig. 3.

Left manus and pes of *Isoodon nauticus*. Manus three times, pes twice natural size.

According to the residents on St. Francis Island, the bandicoot is not uncommon, although it does not exist in anything like the numbers that were met with only a few years ago. Probably we must reckon it as a doomed animal, for on this inhabited island it has to contend with dogs and cats, and still worse, with the fires made to burn off the vegetation of the islands and destroy the nesting mutton birds. It would be very desirable to preserve an adequate series before it is too late, and an effort should be made to transport some of the stock to another island where they would be unmolested.

WALLABIES.

The Pearson Island Wallaby.

Petrogale pearsoni (Thomas, 1922).

That a rock wallaby lived upon the northern portion of the northern island-mass of the Pearson's group has been for years common knowledge to the men employed in the coastwise traffic of the Bight. From its diurnal habits, from its comparatively large numbers in a very limited area, and from its habit of frequenting the tops of the huge granite boulders which constitute the shoreline of the island it is a conspicuous creature, readily seen from the deck of a ship passing under shelter of the eastern side of the group.

It is an exceedingly beautiful wallaby, its markings conspicuous in their contrasts of dark lateral body stripes, white throat and chest, and bushy tufted tail. On such level ground as the island affords its gait appears somewhat

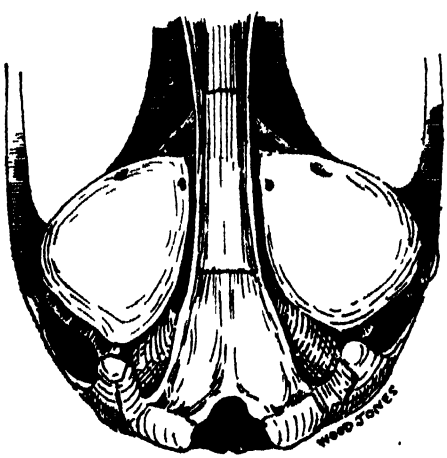

Fig. 4.
Posterior extremity of the base of the skull of *Isoodon nauticus* to show the typical truncated bullae Twice natural size.

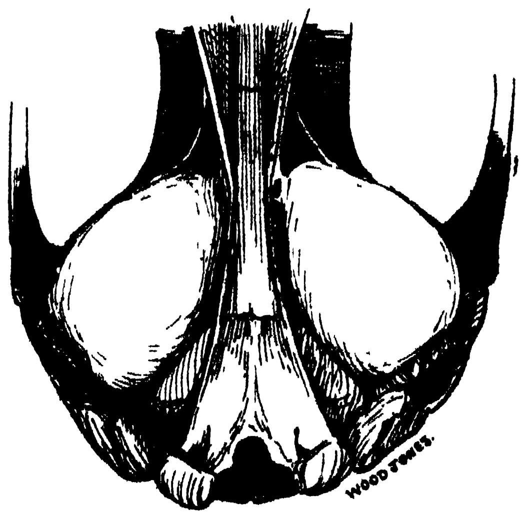

Fig. 5.
Posterior extremity of the base of the skull of a small specimen of *Isoodon obesulus* to show the bullae, which are more elongated than those of *I. nauticus*. Twice natural size.

awkward, for it travels with the head low, and the tail arched conspicuously up behind. It seems that for such progression it has to cant its body forwards at an ungraceful angle, for the tail is not used as a fulcrum as it is in the "scrub" wallabies and kangaroos—it is carried sheer of the ground in all gaits. When one is started across the more or less level saltbush areas it gets away at an awkward gait, using every bush for cover as it goes; but seeming to go in general without regard to its bearings. When it wishes to see where its safest line of retreat lies, or where it is threatened, it stops, puts up its head, and looks around. But, short of stopping, it appears unable to raise its head from its rather ungraceful stoop to take in any wide view. Though it may seem an ungraceful animal on open bush country, it is a very different creature when seen upon the huge, fantastic, granite boulders which constitute the main portion of its island home. Here its movements are astonishing; there seems to be no leap it will not take; no chink between boulders into which it will not hurl itself. There is no part of the northern portion of the islands that it does not inhabit—it is at home on the naked granite boulders of the shore upon which

the surf crashes, and on the lichen-covered boulders of the summit, nearly 800 feet above, where moss, ferns, and casuarinas of large growth constitute a very distinct environment.

It does not exist upon the southern portions of the main northern island, and almost certainly it is absent from the southern detached portions of the group. Its area even on the Pearson group is therefore a peculiarly restricted one, and it is rather remarkable why it should be confined to only one of the three partially connected masses which constitute the complex northern main island.

The wallaby has no obvious natural enemy; the sea eagles, crows, and sea lions may possibly take occasional toll of young or sick, but from its habit of sitting exposed on a rock at any time of the day it would appear that there was but little threat to its safety in the normal condition of its environment. In November some females were seen with large young still in the pouch; in January and February the young are all running with the parents.

Certain points of anatomical interest may be mentioned. In those lizards, such as *Amphibolurus*, which lie basking in the most direct rays of the sun, the viscera are shielded by membranes in which a black pigment is developed. In particular the male genital gland is usually black above and yellowish-white beneath, the surface uppermost in the basking position of the animal being protected by pigment. In *Petrogale pearsoni* the male genital gland is completely enveloped in a pigmented membrane, the tunica vaginalis being almost entirely black. Like the lizards, the wallaby will sit in the hottest noon-tide sunshine, and it appears to experience no discomfort when seated upon a granite boulder so hot that a man could not stand, let alone sit, upon it for any considerable time. The curiously padded feet, with the shortened claws, and lateral fringe of hairs, are very perfect adaptations to the environment of granite boulders; a human being needs rubber soles in order to get about on Pearson Islands, but no rubber sole can rival the rock wallaby's specialized foot (see fig. 7).

It has been noted above that the rock wallaby does not use its tail in the fashion of a typical "scrub" wallaby, and in accordance with this physiological fact is the anatomical condition of the absence of any tail-pad, by which is meant the thickening of the subcutaneous tissues, which marks the contact point of the kangaroo's tail with the ground. The tail of *Petrogale pearsoni* may be pulled out of the skin in the same way as that of a rat—the skin will slip off the underlying tissues because there is no tail-pad. But the tail of a kangaroo or "scrub" wallaby cannot be treated in this fashion, for the tail-pad forms a bond between skin, subcutaneous tissue, muscle, and tendon.

Although the existence of this wallaby has been long known, it is a remarkable thing that no specimens seem to have ever been examined and compared with other, continental, rock wallabies. Since no satisfactory series was available for an adequate study of its nearest allies, a skin and skull were sent to Mr. Oldfield Thomas, and by him the animal was diagnosed as a new species and described under the name of *Petrogale pearsoni* (Ann. and Mag. Nat. Hist., Ser. 9, vol. ix., p. 681, 1922). It is most nearly related to *P. lateralis*, the Western Australian rock wallaby of the Swan River district, and to *P. hacketti*, of Mondrain Island. It is therefore a very far eastern outlier of its group. The description of the type specimen is as follows:—"Size comparatively small, about as in *lateralis*, decidedly smaller than in *hacketti*. General colour, on the whole, very much as in *lateralis*, paler than in *hacketti*. Dark lateral lines of the underside, however, more blackish, those of *lateralis* being dark brown. White patches at the base of the ears larger and more prominent. Tail with its upper- and undersurfaces, from about 3 inches from the base, contrasted black, the sides dull buffy-whitish; above, the black soon fades off into

the brownish terminal tuft, but below it continues to within 2 inches of the tip. This tail colouration is, on the whole, more as in *hacketti* than *lateralis*, but in both there is considerable variation. The usual narrow black dorsal line is continued rather more definitely on to the rump than in one of our specimens of *lateralis*, but the difference may be due to this part being in fresh pelage, and so showing the line more distinctly.

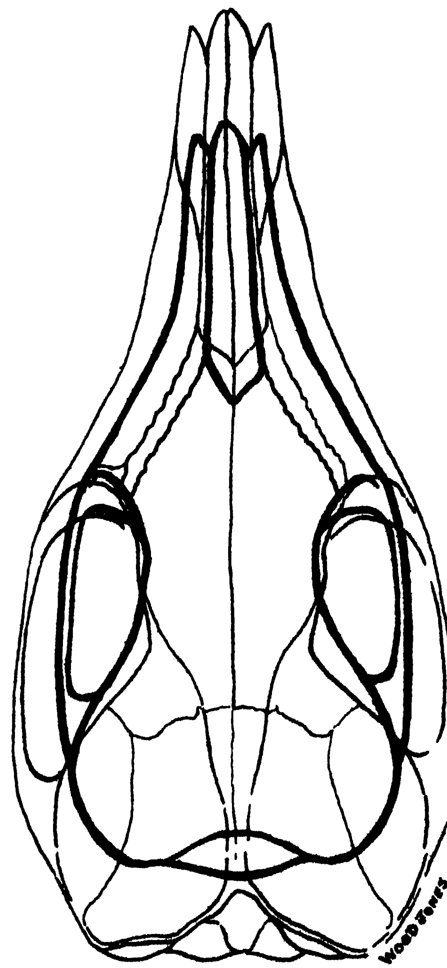

Fig. 6.

The outline of a skull of an adult male *Isoodon nauticus* (thick lines), superimposed on an outline of *I. obesulus* (thin lines). One and three-quarter times natural size.

"Skull in size and general shape quite as in *lateralis*, smaller, and with less heavy supraorbital ridges than in *hacketti*. Palatal foramina comparatively long, about as long as in *hacketti*. In the bullae there is a difference between *lateralis* and *hacketti* which had not been previously noticed. In the former they are fairly well swollen, anteriorly as well as posteriorly, so as to produce a transverse convexity (hardly to be called a ridge), in front of which the bone descends nearly vertically towards the level of the glenoid surfaces. In *hacketti*, however, the whole bulla is larger, but lower and more spread out,

its front part evenly and gradually descending towards the glenoid level without marked transverse convexity. In *pearsoni* the bullae are most like those of *hacketti*, although perhaps a little more swollen. In making this comparison six skulls of *hacketti* and ten of *lateralis* have been available, so that the difference is evidently fairly constant.

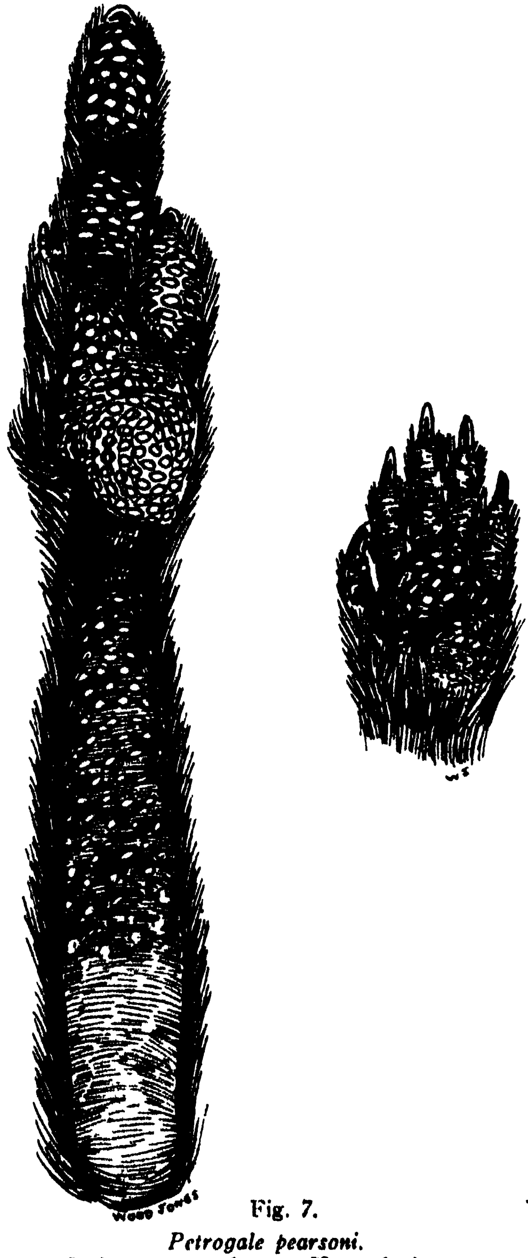

Fig. 7.
Petrogale pearsoni.
Left manus and pes. Natural size.

"Incisors a little larger than in *lateralis*, the whole row 10 mm. in length, about as in *hacketti*, as compared with about 9 mm. in *lateralis*. Secator also slightly larger than in *lateralis*, much smaller than in *hacketti*.

"Dimensions of the type (measured on the re-made skin):—Head and body, 500 mm.; tail (imperfect); hind foot, 136; ear, 43. Skull: greatest length, 94; condylo-basal length, 90; zygomatic breadth, 48; nasals, 39 x 14; palatal foramina, 7·7. Length of I^3, 4·5; of P^4, 6·9. Combined length of M^{1-3} (unworn), 19."

The following table gives the measurements of eleven typical skulls:—

	A	B	C	D	E	F	G	H	I	J	K
Greatest length ..	88	88	91	103	91	94	100	97	99	98	98
Condylo-basal length	85	81	85	95	85	89	94	89	91	92	93
Zygomatic breadth	47	46	46	52	47	47	51	47	51	—	—
Nasals, length ..	36	35·5	37	44	36	38	45	39	42	42	—
Nasals, breadth ..	13	12	13	15	13	13	14	13	14	15	—
Palatal foramen ..	7	7	7	8	7	8	7	8	8	8	7
Length of I^3 .	4·5	—	4·5	4·5	5	4·5	4	4	4 5	—	—
Length of P^4 ..	5	5	6	6·5	5	5	7	7	6	6 5	6
Length, M^{1-3}	17	17	17	19	17	16	18	18	17	16	17

The length of the tail in an average specimen is 500 mm. In the skull there is very commonly developed (4 times in 12 specimens) an os bregmaticum —the so-called os epilepticum of human anatomy—and even when it is absent a sutural irregularity at the bregma is usually present. In a series of skulls of *Petrogale xanthopus* from Bimbowrie the same remarkable little bone occurs with about the same frequency, but, so far, I have not noticed it in any of the wallabies of the Genus *Macropus*.

The skull is remarkable for its very light ossification, the bones of the cranial vault being extremely thin, and compared with the skulls of such wallabies as *Thyogale (Macropus) eugenii* it can only be described as fragile. The teeth are commonly in very bad condition, and in several specimens are enveloped in masses of tartar; alveolar abscess also occurs in connection with the roots of the teeth in two skulls obtained. Like the insular bandicoots and rats, the wallabies are usually extremely fat. The fur swarms with a *Mallophaga*, which readily parts company with a dead wallaby in favour of a living human host; and the intestines of all specimens obtained contained a very heavy infection of nematode worms.

Wallabies of other Islands.

St. Francis Island.—Flinders notes that here "a small species of kanguroo was also found." This animal has been completely exterminated. It seems to have been common enough when the present occupiers settled on the island, but for very many years it has been no more than an apparently not very well preserved memory. There is, unfortunately, no hope that a remnant of the race still exists upon the island.

So far as I know no specimen exists in any collection, and its identity must remain undetermined. Its complete extermination by purposive human effort, without the preservation of even a single skull, is a matter greatly to be deplored.

St. Peter Island.—Flinders records that "at 2 o'clock Mr. Brown and his party returned from the eastern island bringing four kanguroos of a different species to any yet seen. Their size was not superior to that of a hare, and they were miserably thin, and infected with insects."

This wallaby we must also write down as one that has become extinct without leaving a trace behind, and the pity is the greater since quite unusual interest centres round this animal. When Flinders notes that it belonged to a different species from any they had seen before, it must be remembered that he had already seen the wallabies of St. Francis Island and of the islands further to the west.

Again, the fact that St. Peter's was the island which by the French navigators was named L'ile Eugene is important in connection with the nomeclature of certain insular and continental wallabies. A specimen, presumed to be of the St. Peter Island wallaby, was said to have been taken by Peron and Lesueur to Paris,[1] where, first regarded as a young example of *Macropus ruficollis*, it

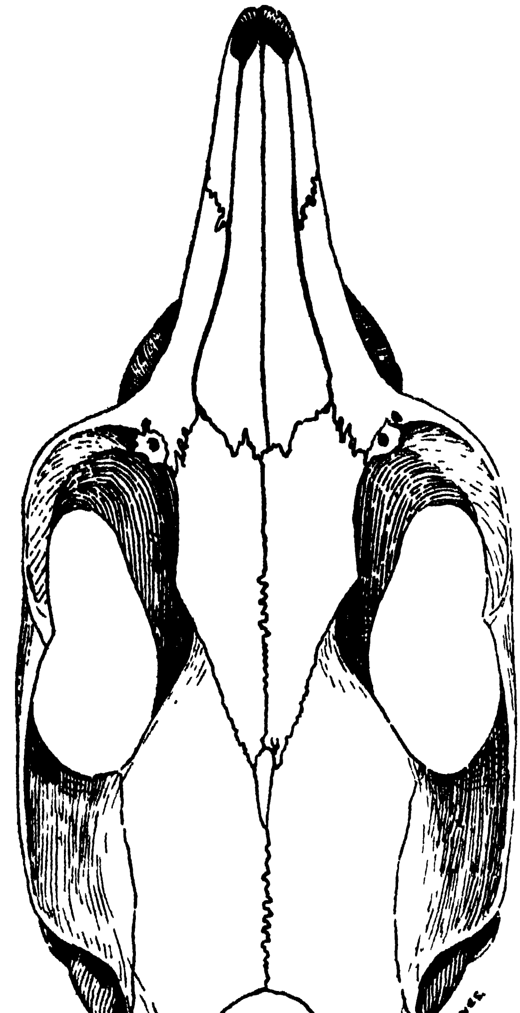

Fig. 8.

Petrogale pearsoni.

Dorsal aspect of skull of an adult male. One and a half times natural size.
A small os bregmaticum is present.

(1) Desmarest's original description is not available in Adelaide, but Waterhouse gives a translation (Mammalia, p. 40, 1846). This description seems hardly to apply to the animal described by Flinders and Peron. Waterhouse also adds this note: — "That specimen, he (Desmarest) says, to his knowledge, once was labelled as being from St. Peter Island, and subsequently the label was changed for one giving Eugene Island as the habitat; both islands, however, are in Nuyts Archipelago." The dual nomenclature of the islands has here led Waterhouse astray. Later on he says of *M. eugenii* that it "is said to be from Eugene Island, on the West Coast."

was subsequently described by M. Desmarest as *Kangurus (Macropus) eugenii.* The actual type specimen no longer exists in the Paris Museum, and the description of it does not well accord with the accounts of the navigators. The question may therefore be very legitimately asked if the St. Peter or Eugene Island wallaby appears, from the descriptions of the early navigators themselves, to have been the animal which is now known as *Thyogale (Macropus) eugenii.* Peron and Lesueur give us the following account:—"Le kanguroo existe en grand nombre sur L'ile Eugene, ou l'on peut en faire un chasse productive; nous ne l'avons point vu sur le continent. Ce quadrupede parvient au poids de huit a dix livres (quatre a cinq kilogrammes): sa foururre est epaisse son poil tres fin et d'une belle couleur rousse tirant sur le brun." In the first place, a weight of eight to ten pounds is quite inadequate for the wallaby now known as *eugenii,* for that animal weighs three times as much. Again, the statement of Flinders that its size was "not superior to that of a hare" makes it appear almost certain that the so-called Dama wallaby was not the animal which Flinders saw. The description of the pelage as given by the French naturalists could not, even allowing for the inexactness of colour terms, be taken as typical of the present *eugenii.* We can only conclude that the animal which Flinders saw, and of which Peron and Lesueur gave their account, is now entirely extinct upon the island on which it originally lived, and that it almost certainly was not the animal which is now known as *Thyogale eugenii.* What it was can only be guessed at, and that is a business of but little utility in science; we might hazard that it was a member of the Genus *Lagorchestes,* or, maybe, *Bettongia;* it may have been the same "kangaroo rat" as was only recently exterminated on St. Francis Island; but beyond that we cannot go.

When it was exterminated on St. Peter Island, I do not know. St. Peter Island is a considerable land mass, and has long been inhabited. It is high time it was thoroughly examined, and its remaining flora and fauna studied.

In connection with this animal there is another point worthy of note. It is usual in South Australia to allude to the West Coast of Eyre Peninsula as "the West Coast." This custom has led to considerable confusion, for the term "Islands of the West Coast," though well understood locally, has more than once caused the habitat to be given as islands on the West Coast of (Western) Australia.

Flinders Island.—Of the wallaby of this island Flinders says, "A small species of kanguroo, not bigger than a cat, was rather numerous. I shot five of them, and some others were killed by the botanists and their attendants, and found to be in tolerably good condition."

It is a pleasure to be able to report that the Flinders Island wallaby is not extinct. When I visited the island in November, 1920, I searched as much of the scrub-covered portion of this large island as was possible in the time, and I saw no trace of the wallabies. Mr. May, who has long been resident on the island, was convinced that they had been extinct for the last ten years. When they were abundant their range on the island had been somewhat restricted, and in 1910 a destructive bush fire swept over their portion of the island. Since 1910 no trace of the animals had been seen. I visited the island again in 1922, and very soon after landing came upon wallaby tracks; evidently quite a flourishing little colony inhabited their old area. No living animal was seen, and a dog pressed into the service failed to start any. At this end of the island the bush is dense and affords them excellent cover; nevertheless, Mr. May informed me that of late he had seen them on several occasions.

What species it may be cannot be definitely stated. Before 1910, when wallabies were abundant on Flinders Island, Mr. May is very definite that two species were present—the one, a grey-brown animal, was very common; and the

other, a yellow, slender, and smaller kind, was much more rare. I have had this account of a yellow wallaby on Flinders Island corroborated from a quite independent source.

In the Adelaide Museum are three wallaby skulls from the island, received in 1892. These skulls have the name "*Macropus eugenii*" pencilled on them, and are so registered. In their general features they offer no striking differences from the Kangaroo Island wallaby; but one skull bears a tied-on label stating that it belonged to a "light and uniform coloured wallaby," which is scarcely the description of the pelage of a normal *eugenii*. For the present we must be content to know that the animal, be there one species or two, is living

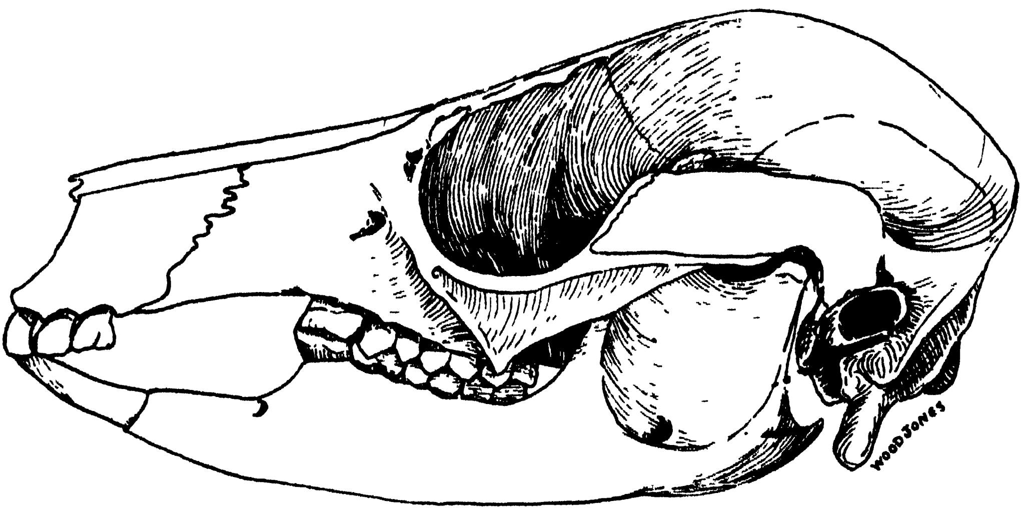

Fig. 9.

Petrogale pearsoni

Lateral view of the skull of an adult male. One and a half times natural size

For the future, it is surely a duty incumbent on our scientific institutions to rescue some of the remaining stock and place it in the sanctuary of Flinders Chase.

The following are the measurements of the three skulls in the Adelaide Museum:—

	? No 1749.	Male. No. 1750.	? No. 1751
Greatest length	90	91	97
Condylo-basal length	84	85	92
Zygomatic breadth	46	49	49
Palatal foramen	3	3	4
Length of I^3	5	4	4 5
Length of M^{1-3}	15	16	17

PRICE ISLAND.—When on the top of Price Island in 1920, I noted what I felt certain were the runs of wallabies, though I saw no definite foot prints. The bush vegetation of the island plateau is very dense in certain places, and affords plenty of cover. It is possible that what I saw were the runs of the descendants of a pair of Kangaroo Island wallabies landed some years ago upon the island; but owing to the difficulty of landing these animals in the heavy sea that was running at the time, it is open to doubt if both members of the

pair gained the top of the island in safety. A more prolonged stay upon the island would probably be well rewarded.

GREENLY ISLAND.—This beautiful granite island is very like the islands of the Pearson group as far as its geological formation and its vegetation are concerned. During my visit in 1920 I noted dejecta which I think were undoubtedly those of a wallaby, and other members of the party made the same observation independently. Yet no animal was seen, and this is rather surprising, since it would almost certainly be a rock wallaby, and these creatures are likely to be met with during a day-time visit to the island. Further examination of this grand granite pile (upon which the landing is at times by no means easy) should be undertaken later.

OTHER MARSUPIALS.

One animal, the quite recent extermination of which we must greatly regret, is the small unknown creature which used to live in great numbers on St. Francis Island.

These little animals were always spoken of by the late Mr. Lloyd, of St. Francis Island, as "tungas,"[e] a name by which he said a somewhat similar animal was known in his young days on the Nullarbor Plains. He described them as very small wallabies, creatures which used to hop into the homestead and eat scraps thrown to them from the table.

According to Mr. Arnold, sen., they were properly known as "talkies," a word which appears to be an obvious corruption of "thulka," a native name used widely in the northern parts of South Australia as a designation for *Thalacomys lagotis*. Mr. Arnold also speaks of them as "kangaroo rats," but does not think that they ever lived on the mainland.

No description precise enough to be of real use can now be obtained, and it serves little useful purpose to speculate upon its identity.

Cats were liberated in order to destroy it, and they have done their work with thoroughness.

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[e] This name is employed in certain parts of South Australia to designate the *Bettongias*. If the exterminated animal was a member of this genus it was probably *B. penicillata*.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 7.—THE FISHES.

By Edgar R. Waite, F.L.S., C.M.Z.S.
(Contribution from the South Australian Museum.)

[Read April 12, 1923.]

Plate III.

The majority of the fishes here recorded were obtained with hand lines from either the "Simplon" (1914) (1) or the "Wokata" (1923) or from the rocks during our sojourn on Pearson Island. No rock pools were exposed at low tide, and it may be said that none exist, the granite everywhere descending precipitously or by a gradual slope into the sea. To the west and close behind our camp two large conjoined pools were found; they are situated far above high tide line, but receive considerable volumes of water as a result of the waves breaking against the rocks. It was on a rock about 10 feet above the level of these pools that I found the encrusting coral exhibited. To work this pool for fishes seemed to be a forlorn hope; a narrow crevice connecting the two pools harboured a strong growth of seaweed, and an investigation of this weed yielded the *Cristiceps* and *Ophiclinus* listed, together with several Nudibranchs and Crustaceans. The following is a list of the fishes obtained:—

Sphyraenidae: *Sphyraena novae-hollandiae*, Gunther.
Cheilodactylidae: *Threpterius maculosa*, Richardson
Labridae: *Pseudolabrus tetricus*, Richardson; *Pictilabrus laticlavius*, Richardson; *Achoerodus gouldii*, Richardson.
Blenniidae: *Ophiclinus gracilis*, Waite; *Clinus perspicillatus*, Cuvier and Valenciennes.
Monacanthidae: *Cantherines hippocrepis*, Quoy and Gaimard.
Diodontidae: *Allomycterus jaculiferus*, Cuvier.

Threpterius maculosus, Richardson.

Pl. iii.

D, xiv., 18; A, iii., 8; V, i., 5; P, 7+8; C, 13+4; L, l., 54; L, t., 11+21.

Length of head, 2·9; height of body, 2·7; length of caudal, 4·37 in the length, caudal excluded. Diameter of eye, 3·75; length of snout, 5·5; interorbital space, 6·6 in the head.

Head very low at the eyes, rising abruptly to the dorsal fin; interorbital space flat, narrowest in front; upper profile angular, posterior nostrils situated on each side of a protuberance above the front margin of the eye; anterior nostril, lower, in front of the eye, within a low rim which has a skinny flap behind. Eye very large, touching the upper profile, its depth equal to that of the area below it, mouth oblique; the upper jaw formed wholly of the premaxilla; maxilla expanded behind, extending to beyond the middle of the eye. Strong canine teeth in both jaws, in a single series; similar but smaller teeth on the

(1) Waite, Trans. Roy. Soc. S. Austr., xxxix., 1915, p. 455.

vomer, forming a V-shaped row; palatines and tongue edentulous. Preopercle much bowed, margin of opercle sinuous.

Body elevated behind the head; its deepest point at the insertion of the seventh dorsal spine, whence it curves regularly to the last dorsal ray, thence straight to the tail; the curve of the under profile is low.

Fins.—The first dorsal spine arises over the margin of the preopercle, its length is less than the diameter of the eye, the sixth spine is the longest, a little less than twice the diameter of the eye. The membrane forms a fine free pennant behind each spine. The length of the base of the spinous is less than that of the soft dorsal; the longest soft ray is half the length of the head. The Anal commences below the origin of the soft dorsal and has a short base; its second, or longest ray, is one-fourth longer than the longest ray of the dorsal. The Pectoral extends as far as the vent, the two upper and eight lower rays are simple, the distal portion of the latter being free. The Ventral arises below the seventh dorsal ray; its length is nearly three-fourths that of the Pectoral. The Caudal is slightly rounded, and the depth of its peduncle is 3.4 in the height of the body.

Scales.—Scales cycloid on the body and opercle, head otherwise naked, but with fine striae and vermiculations. Lateral line almost straight.

Colours.—Greenish-brown, with irregular dark blotches on the head; blotches on the body above, and spots below the lateral line; an oblique black bar below the eye and a silvery spot on a black ground on the opercular lobe. soft dorsal and anal with hyaline spaces and black spots. Pectoral, Ventral. and Caudal with faint darker bars.

Length of specimen described, 215 mm.; another seen was 255 mm.

Two examples were caught on hand lines from the rocks, close to the camp. Richardson remarks that "it frequents rocky places." His [2] description and figure were made from a dried specimen which appears to have lost its characteristic shape. The figure is too elongate, and does not sufficiently show the contour, which proves to be very similar to *Goniistius*. The maxilla is incorrectly illustrated as entering the gape, and the dorsal spines appear to be too low and too uniform in height; the pectoral is shown as extendng only half-way to the anal instead of almost thereto. Other discrepancies will be apparent on comparison with the figure here supplied. The type of the species was taken in King George Sound, Western Australia.

(2) Richardson, Proc. Zool. Soc., 1850, p. 70, Fishes, pl. ii., figs. 1, 2.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 8.—THE ECOLOGY OF PEARSON ISLANDS.

By T. G. B. Osborn, D.Sc., Professor of Botany in the University of Adelaide,
with an Appendix on the Soils,
By J. G. Wood, B.Sc., Demonstrator in Botany.

[Read April 12, 1923.]

Plates IV. to IX.

The following account of the ecology of Pearson Islands is based on observations made during a stay on North Pearson from January 5 to 12 of this year. I desire to express my thanks to Prof. F. Wood Jones, leader of the party, for assistance in various ways, and to Mr. T. D. Campbell, for permission to make use of his sketch map of the islands in constructing text fig. 1.
The party is indebted to Sir G. J. R. Murray, K.C.M.G., for a generous donation towards the cost of the expedition.

Pearson Islands lie in lat. 33° 58′ S., long. 134° 15′ E., at a distance of about 40 miles from the nearest mainland, the west coast of Eyre Peninsula, South Australia. They are, however, only 18 miles south-west from Flinders Island, a comparatively large island, the area of which is 9,000 acres. They are the south-western islands of the Investigator group, and were named by Matthew Flinders in 1802, but were not visited by him. Robert Brown, who was naturalist on board H.M.S. "Investigator," did not, therefore, land upon them, and, as the islands are uninhabited, with a rather uncertain landing, it is improbable that they have been visited by a botanist before.

According to the Australia Directory (1) the Pearson group consists of four islands and a rock partly above water. This paper refers only to the North Island of the Directory, which is the largest and most important. No landing could be made on any of the other islands. Two of them are too precipitous for any landing, though one might be effected upon the third. A careful examination of the vegetation upon them by means of field glasses indicates that the flora is of the same type as on the more exposed parts of North Island. These outlying islands will not be referred to again in this account.

PHYSIOGRAPHIC FEATURES.

The North Island of the Australia Directory consists of two, or, for descriptive purposes, preferably three land masses lying close together (text fig. 1). The southern land mass is connected with the middle one by an isthmus of bare granite boulders, which is above high-tide mark, but would in storms be entirely spray drenched. The northern land mass, which is the largest, being about 1½ miles long by 1½ miles broad, is separated from the middle one by a strait about 100 yards across, and can only be reached by wading at low tide in calm weather. In the following account the North Island of the Australia Directory will be spoken of as if it were three separate islands, called respectively Northern, Middle, and Southern. The group consists of exceedingly bold, rugged, granite islands rising in one place on Northern Island 781 feet (2) above sea level. The

(1) Australia Directory, 10th Edition, p. 169, 1907.

(2) The altitudes are taken from the Hydrographic Survey, Australia Directory, *loc. cit.*

granite comes as sheer cliff, jumbled boulder, or sloping pavement to the sea on all sides except for a small sandy beach, the landing place, on the east side of Middle Island. The south and west faces of the islands are most rugged, and in places precipitous cliffs rise 200 feet or more. The ocean swell of the Great

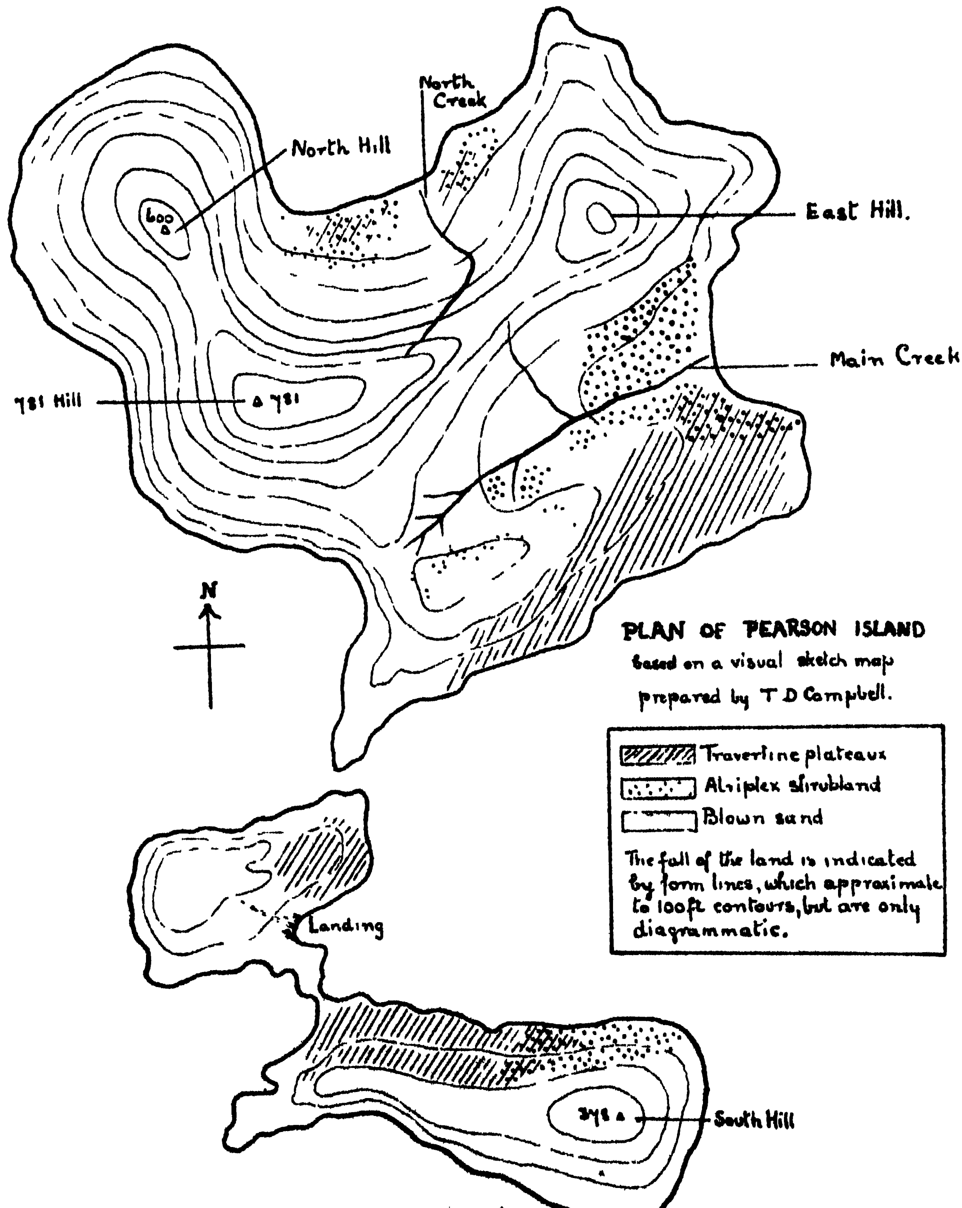

Fig. 1

Australian Bight, driven by moderate winds, dashes with great force against these walls, sending spray high in the air. In rough weather and in winter the seas must be very heavy, and the spray be carried by the gales for some distance inland. This is seen by the occurrence of such halophytes as *Arthrocnemum* and *Sueda* 200 to 300 feet above sea level.

Northern Island is divided into two unequal portions by a watercourse running roughly south-west to north-east, hereafter called Main Creek. To the north of this are three bold granite summits. The highest lies above the head of the creek, rising 781 feet, and called 781 Hill. This is connected with the two other peaks, each about 600 feet high, by necks of high land. The eastern, East Hill, rises above the mouth of Main Creek, with only a narrow col, that in places is a bare granite ridge 3 or 4 yards across, connecting it with 781 Hill. Between North and East Hills is a beautiful sheltered bay, the shore of which is bare granite. North Hill and its neck rise precipitously from the shore of this bay, but the slopes of East Hill and the col to 781 Hill rise more gradually with an interesting talus slope that is traversed by a torrent bed (North Creek) draining from 781 Hill. Between 781 and East Hills is another watercourse draining the south side. This creek has a less precipitous bed; it is a tributary of Main Creek.

Granite tors and boulders occur on most of the hilltops and exposed slopes of these islands (pl. iv., fig. 2), but 781 and North Hills are remarkable for the large slopes of bare granite that occur even upon their sheltered faces (pl. iv., fig. 2, and pl. vi., fig. 2). These bare rocks are even expanses, in some cases over an acre in extent. Some are precipitous, but many slope at only a low angle and then end abruptly with a cliff 6 to 10 feet high. They are generally without any vegetation except for algae that mark the watercourses across them. The dark olive-green or black of these lines is in striking contrast to the grey-brown of the granite rock. Such slopes serve as huge catchment areas from which there is an immediate run off. The ground at their lower edge, however, has a low water-holding capacity, and the drainage water falling on it serves rather to leach soluble salts out of it than to increase its fertility. The soil immediately below these slopes, then, is often coarser and more barren than is that further away.

The southern portion of the Northern Island has no striking physiographic features. Its western end has bold granite tors; towards the eastern end it slopes gradually to the sea. Much of the area is a travertine limestone plateau.

Middle Island (pl. viii., fig. 2) has a much smaller area, consisting of a low summit, estimated at somewhat over 200 feet high on the west side, and falling precipitously to the sea. The fall is more gradual on the east side with talus slopes that spread as a fan upon a small travertine plateau. This latter occupies about a quarter of the area of the island. At the south side of this island is the small sandy beach that forms the only landing place on the group. The sand is limited to a patch about 50 yards square, though some—blown from the beach—lodges in the cracks of the granite slopes lying immediately behind.

Southern Island has two peaks, one a mere collection of bare tors; the other, South Hill, near its south-east point, is 378 feet high. The two peaks are connected by a ridge, the exposed southern face of which is a sheer precipice nearly 200 feet high. The coast, immediately below South Hill, is a sloping pavement of granite swept bare by waves for over 100 feet. Southern Island also has its travertine plateau, occupying almost a third of its area.

Travertine Limestone.

The travertine plateaux are a striking feature of the three islands. From the sea they are at once recognizable by their more level appearance and the different colour of the vegetation they support. The travertine limestone lies near the surface of the soil, but is usually exposed only at the cliff faces. The overlying soil and underlying rock are obviously of granitic origin, more or less cemented in the underlying portion by limestone. Shells of a land-dwelling

gasteropod occur in a subfossil state in the consolidated rubble below the limestone bed. Professor W. Howchin has kindly determined these shells as *Bothriembryon mastersi*, Cox. Professor F. Wood Jones informs me that similar shells in a living state occur on the surface of the islands to-day. As travertine is a very recent or modern geological formation, the occurrence of a living species in a subfossil state is not surprising. The travertine limestone that is now present overlying the granite is probably only the remains of what was once a thick deposit of calcareous sand. This has now been eroded, leaving the limestone as an indication of its former presence.

The islands of the West Coast are the remains of the old coast of South Australia that, during the Pleistocene period, was south and west of its present line. The islands and neighbouring portions of the mainland consist of indurated sands resting upon a platform of older rocks. This platform is generally a few feet above or below sea level. It represents, according to Howchin,[3] who has examined the structure of the islands and mainland eastward of Cape Catastrophe, a base level of erosion, probably marine. At some post-Miocene time this platform became covered by calcareous sands left by the sea in its line of retreat. Huge dunes must have been formed, for some of the islands, *e.g.*, Thistle Island, show a thickness of sand over 700 feet. Still more recently the sea returned and is now wasting away the soft wind-constructed sand left in the line of its former retreat.

There is no reason to doubt that the area which is now Pearson Islands received a deposit of calcareous sand, but it is open to question whether this deposit was continuous over its highest parts. No travertine was found on the hillsides above 200 feet. The opinion is expressed that even at the period of maximum sand covering, the present hilltops (at least, of Pearson Islands), projected as granite outcrops. Such granite outcrops are common on the mainland in Central Eyre Peninsula to-day, and they bear a flora which is different in constitution from that of the porous sandy soil around them. Certain of the plants found on Pearson Island are of this "granite-outcrop" type of flora rather than sand dune. The occurrence of a rock wallaby *(Petrogale pearsoni)* that is unknown on the mainland, also indicates that a rocky outcrop has been a feature of the Pearson area for a great length of time.

ENVIRONMENTAL FEATURES.

I. Climatic.

Rainfall and temperature data were given in a previous paper on the Franklin Islands[4] for the two nearest meteorological stations on the mainland. These lie to the north of the Pearson group, so that they represent a more extreme type of climate than that existing there, especially as the Pearsons are islands lying well out in the open sea. The general climatic conditions, shown in the table for Franklin Island, of winter rainfall and a dry summer, with probably one or two completely rainless months, will therefore hold for Pearson Islands. The temperatures are likely to show a smaller range, days of over 100° F. or more in the shade are unlikely, as are frosts. No more positive data than those cited can be given, but observations made during a week's stay on the islands suggest some additional features of the climate.

The prevalent winds are south-west, and are often of great strength. Shearing action by the winds is well shown by shrubs exposed to their violence. The most striking examples occurred at the head of Main Creek. There the trees of *Melaleuca halmaturorum* have a prostrate habit (pl. iv., fig 2). One old tree measuring 24 feet in length and 8 inches in diameter at the base is growing

(3) Howchin, W., Proc. Roy. Geogr. Soc. S. Austr., x., pp. 204-219, 1908.

(4) Osborn, T. G. B., *loc. cit.*, p. 197.

quite flat upon the ground, and the foliage, which is confined to the terminal branches, is spread as a bushy carpet.

The presence of three peaks—600 feet high or over—upon North Island causes raincloud or mist to hang about the higher levels to a considerable degree. Thus, on the morning of our landing there was light rain about 6 a.m., and the peaks were blotted out by clouds. These gradually lifted as the sun rose, but they hung about the top 200 feet or so of 781 Hill until nearly 11 a.m. In winter this cloud effect must be considerable. The ground flora at and just below the summit of 781 Hill includes several mosses, and the fern *Cheilanthes tenuifolia* suggesting a greater humidity than lower down the slopes or even along the water courses.

The insolation factor upon the islands must be very severe, and aspect differences between north or west slopes and south or east are marked. The two former are much drier and the rock weathers more rapidly than in the case of the latter. This is particularly well seen in the case of East Hill when viewed from the col connecting it with 781 Hill (pl. iv., fig. 1). The north face has precipitous granite tors and rocky slopes supporting an open flora of shrubs; this extends almost to the summit. On the south face the angle of the slope is lower with less bare rock. *Casuarina* woodland, which is the climax community on hill summits, extends down the slope for some distance on the south side, and when it passes into scrub communities the latter are thicker and less open.

II. Edaphic.

In Appendix I. Mr. J. G. Wood gives the results of certain analyses made of soil samples collected upon the islands. There are three soil types on the Pearsons—blown sand, travertine, and granitic.

The first, as described above, is limited to a small patch at the south end of Middle Island near the landing place. It need not be considered further.

The travertine soils consist of a coarse granitic sand mingled with particles of limestone of all sizes from small fragments to large blocks several square feet in area. The soil appears to dry out very thoroughly; in January there was no cohesiveness between the particles at a depth of 8 to 9 inches Below this depth large travertine masses form the main deposit. The sample of travertine soil analysed was collected from the middle of Southern Island. The analysis (Sample 1) shows that there is 6 per cent. humus, 9·7 per cent. calcium carbonate, ·38 per cent. nitrogen, ·79 per cent. sodium chloride. It was distinctly alkaline pH=8.

The granitic soils range from talus and rubble to coarse sands. The water-retaining capacity of such soils is low, and the rain that falls upon them would rapidly percolate to the solid rock below. These soils are invariably dry and powdery to the touch. The samples felt "air dry" at the time they were collected. Five samples were taken, one in each of the two main communities—*Atriplex*, "saltbush," plain (Sample 2), *Casuarina* woodland (Sample 3)—and three in Main Creek, at the head and in the upper part, to test the range of salinity in the soil (Samples 4, 5, and 6).

Samples 2 and 3 show a general similarity. The *Casuarina* woodland has, as might be expected, the higher humus content, 13·9 per cent., as against 9·9 per cent. in the saltbush soil. Both soils have only average salinity (·20 per cent., ·23 per cent.). The most striking difference is in the pH values. The woodland soil has an acid reaction pH=6; the saltbush plain is somewhat alkaline, pH=7·4.

Sample 4 is typical of much of the poorer soil on well-drained slopes. Such soils are poor in humus and soluble salts. Samples 5 and 6 were taken respectively at the edge of and within one of the granite basins that occur at

the head of Main Creek. Sample 6 is clearly affected considerably by the evaporation of sea water. It has a high salt content, sodium chloride 3·08 per cent., but is poor in humus, 3·8 per cent., and also in nitrogen, ·07 per cent.

All these granitic soils, except that from the *Casuarina* woodland, are neutral or on the alkaline side of neutrality.

III. Biotic.

Biotic factors in the environment do not have so obvious an effect upon the flora of the Pearsons as they have upon the Franklins.[5] The soil is unsuitable for the burrowing activities of either the mutton birds or penguins, which were so abundant there. Mutton birds are absent and the penguins have to nest under rocks. The only grazing animals are the indigenous wallabies *(Petrogale pearsoni)*, which are frequently seen on Northern Island. Their chief food plant appears to be *Atriplex paludosum*, but their feeding does not damage the bushes appreciably. One strange feature is the remarkable abundance of the droppings of some insect. These occur thickly on the surface of many soils, especially in the *Olearia* shrubland and the lower slopes of the *Casuarina* woodland. The faeces are hard, black pellets, roughly cylindrical, 2 to 3 mm. long by 1 mm, in diameter. They are extraordinarily frequent in some places and can be swept up off the soil by the handful. Mr. A. M. Lea, Entomologist of the S.A. Museum, kindly informs me that they resemble the dung of a cockroach. A large species of this insect is generally found under stones on the island. Judging by the amount of dung, they must occur in very large numbers at some seasons. Presumably they feed on vegetable *debris*, which they return to the soil in a form that is not readily removed by wind or leeching. The deposit is so abundant as to affect considerably the percentage of nitrogen in the soil anlayses.

Human interference with the vegetation is limited to the results of one or two fires that have been started on the islands by visiting vandals. The effect of these has been almost to destroy the Casuarinas south of Main Creek; elsewhere the burnt-out flora has regenerated well. Several years ago a number of sheep were landed upon the Northern Pearson. There are none there now, and the vegetation appears uninfluenced by them, unless the grass *Festuca bromoides* was brought to the island by this means. *Festuca bromoides* was the only non-indigenous Australian plant collected, except the variety *littoralis* of *Sonchus asper*.

VEGETATION.

Three main vegetation types occur on the Pearsons, exclusive of various communities on cliff faces, creek beds, blown sand, etc., which are not easily placed in relation to the others. They are:—(1) The woodland and scrub series on granitic soil with a climax of *Casuarina stricta* woodland; (2) saltbush consisting of *Atriplex paludosum* dwarf shrubland, occurring chiefly on granitic soil; and (3) the various communities on travertine limestone. The first two types may be considered as formations, and the ecotone lines are usually clearly distinguishable. An exception occurs on the right, or south, bank of Main Creek. There the blurring of the line appears to have been affected to some degree by fire. The last series, as explained below, is formed merely as a matter of convenience.

Woodland and Scrub Series.

I. *Casuarina stricta* woodland.

A woodland, or "forest," of *Casuarina stricta* occurs on the three large hills of Northern Pearson. The trees grow to a height of 20 to 30 feet (pl. v., fig. 1). The length of the green assimilating branches varies considerably with

(5) Osborn, T. G. B., *loc. cit.*, p. 203, 1922.

the degree of exposure. In exposed places they may be no longer than 6 to 8 inches and stand erect, while in sheltered parts they are 18 to 24 inches long and bend with a graceful curve, giving the familiar rounded silhouette to the trees.

Casuarina stricta woodland is only a closed community in the most sheltered parts of 781 Hill. In other parts there is an underwood of various trees or shrubs, *e.g.*, *Melaleuca parviflora*, *Leucopogon Richei*, which mingle and compete with the sheoak. The soil is coarse with a humus content of 13.9 per cent., but has only a low water-retaining capacity. In places between the granite boulders there is a considerable depth of soil. Frequently the "forest" ends abruptly (pl. v., fig. 1), owing to the presence of some large exposure of granite. Several such places occur on 781 Hill, and one passes at a step from the climax to the earliest phases in the succession. In the woodland the ground below the trees is covered by a litter of fallen branchlets, old fruits, or tree trunks. The forest suffered several years ago by fire, but it is generally regenerating well; many seedlings and young trees of various ages occur.

Mosses are common, but in January were quite dried up. Mr. L. Rodway, C.M.G., of Hobart, kindly determined the following: *Bryum intermedium*, *Tortula muralis* (form with a cuspidate hair point), and (?) *Acanthocladium*, sp

Herbaceous plants of the most sheltered places are:—

Cheilanthes tenuifolia	*Agropyrum scabrum*
Festuca bromoides	*Didiscus pusillus*

During the winter and spring no doubt others would be found, but at the time of our visit they were not to be seen. These herbaceous plants disappear on hotter or more exposed places, *e.g.*, the west face of the summit of 781 Hill and xerophytic perennials as *Mesembryanthemum aequilaterale* replace them. Several colonies of *Senecio Cunninghamii* were found in sheltered places on 781 Hill. This is a half-shrubby plant with lanceolate leaves 8-12 cm. by 8-12 cm. that are glossy above and glaucous on the lower-surface. It has a less xerophytic appearance than any other perennial on the island.

The undershrub flora varies with differing degrees of dryness and exposure Just below the summit of 781 Hill, on the north-east side, there is an open area with bushes of *Calythrix tetragona*, found nowhere else on the island. The most usual undershrub in the more sheltered places is *Leucopogon Richei*, which, though it appears in the open shrub association described below, is not found in the most exposed places of the *Casuarina* woodland. Other plants occasionally associated with *Leucopogon Richei* are *Dodonaea viscosa* and *Cassinia spectabilis*.

In more exposed places, *e.g.*, the summit of 781 Hill, on East Hill, especially at the col and on the lower slopes, *Melaleuca parviflora* appears as the undershrub and even replaces *Casuarina* (pl. v., fig. 2). It develops a distinct and more xerophytic community. Transitions were seen in many places, but most clearly on slopes with a northern aspect (pl. iv., fig. 1). The fire, or fires, referred to earlier appear almost to have destroyed the Casuarinas of the north facing slope above the right branch of Main Creek. *Melaleuca parviflora* forms a dense thicket in which only a few Casuarinas are present. On Southern Island there is a small group of about half a dozen stunted Casuarinas growing on the most sheltered part of the north side. This represents a small outlier of the *Casuarina* woodland which has every likelihood of dying out, since none of the trees were fruiting nor were any old fruits to be seen below them.

II. *Melaleuca parviflora* scrub.

A mixed scrub community in which *Melaleuca parviflora* often attains the size of a small tree occupies the foot of 781 Hill and other hills on Northern Island (pl. iv., fig. 2). The plant is absent on Middle and Southern Islands.

It rarely exceeds 15 feet in height and frequently has several slender stems terminating in a dense canopy of foliage-bearing shoots. The association is generally an open one, other shrubs being:—

Rhagodia baccata
Correa speciosa
Spyridium eriocephalum
Pimelia serpyllifolia
Westringia rigida, var. *dolichophylla*
Myoporum deserti
Olearia ramulosa

The soil is a coarse granitic sand of much the same type as in the *Casuarina* woodland, but lacking the dark colour due to humus. It was bare of annuals in January, nor could any sign of their dead remains be seen. A small number of perennial species occurs in open places; these are plants characteristic of earlier phases of the succession, *e.g.* —

Poa caespitosa, var. *Billardieri*
Mesembryanthemum aequilaterale
Scleranthus pungens
Pelargonium australe

Atriplex paludosum occurs in several open areas on the north side of Main Creek as small inliers of saltbush plain (pl. viii., fig. 2).

III. *Olearia-Leucopogon* thicket.

A mixed community of shrubs, of which *Olearia ramulosa* and *Leucopogon Richei* are the most important, exists on some of the lower slopes of the hills of Northern Island, covers South Hill so far as exposure will allow, and occurs also on Middle Island. More than one association is probably involved here, but there is so much intergradation between the differing habitats owing to exposure, the broken nature of the ground, etc., that it is inadvisable to attempt to define different communities.

The conditions of development of this *Olearia-Leucopogon* associes are generally similar to those producing *Casuarina* woodland or *Melaleuca* scrub at higher levels or where exposure is less severe. The soil is granitic sand held in clefts of various depths, or terraces between the boulders or tors. Exposure to heat and wind is greater than in the case of the two former communities, while the soil is less stable owing to the more rapid weathering of the rocks. The effect of aspect and exposure on the development of this thicket has been referred to in the case of East Hill (pl. iv., fig. 1).

Other plants noted as occurring in this community are:—

Rhagodia baccata
Enchylaena tomentosa
Lepidium foliosum
Correa speciosa
Mesembryanthemum aequilaterale
Myoporium insulare

On Middle Island and portions of Northern Island, near the head of Main Creek and the south-west corner of the island generally, it is not possible to define the communities even within the broad limits mentioned above. The conditions in these localities are less stable owing to weathering of the rock, extremes of exposure to the south-west gales alternating with comparative protection in hollows of the rock, the possible influence of spray, and so on. In addition to the plants mentioned others are present that are the earliest colonists of rubble soil. Such are:—

Poa caespitosa, var. *Billardieri*
Scleranthus pungens
Pelargonium australe

Occasionally are found bushes or local patches of *Atriplex paludosum* which typically occurs as the dominant in a distinct community.

IV. *Pelargonium-Mesembryanthemum Poa* community

This is the earliest phase noticeable in the colonization of granite rubble in shallow pockets in the rock on all the islands. The community is composed of *Pelargonium australe, Mesembryanthemum aequilaterale,* and *Poa caespitosa,* v. *Billardieri.*

The pelargonium is low growing with succulent half-shrubby stems. The plant has a stouter habit of growth than it has when growing on sand dunes on the mainland. *Mesembryanthemum aequilaterale* is another dune plant which on Pearson Island has a less spreading mat habit than is usual *Poa caespitosa,* v. *Billardieri,* has wiry, pungent-pointed leaves, and the short straw-coloured panicles typical of the variety. These plants appear in exposed, barren soil at all levels. Thus, at the summit of 781 Hill the *Mesembryanthemum* and *Poa* are growing along the exposed precipitous western face They also occur on the bare patches of coarse sand in the upper part of Main Creek There the soil (Sample 4) is poor and deficient in soluble salts. Transitions between this community and the *Olearia-Leucopogon* thicket are common. The shrub appearing first is *Olearia ramulosa; Rhagodia baccata* less commonly. The annual *Lepidium foliosum,* too, is often found, as is the cushion plant *Scleranthus pungens.*

Communities on the Granite Cliffs.

Exposed, precipitous, granite cliffs occur on most parts of the islands. The type of vegetation they bear is largely a depauperate form of the neighbouring less exposed faces, but it seems permissible to refer to cliff floras. Naturally, an important factor influencing these is the degree of exposure to salt spray.

In the most exposed places the cliffs, or platforms, of rock that rise at an angle of 30° to 45° from the sea are entirely bare for 100 to 150 feet above tide marks. In rubble pockets above this height occur such plants as *Mesembryanthemum australe, Salicornia australis,* and *Sueda australis.* These all grow stunted in small mats. The habitat is not suitable for most flowering plants, and even lichens and algae are absent. The relatively rapid weathering of the rock faces may account for this, as well as exposure to heat, wind, and spray. The surface of the granite in these places is either smooth where exposure is most severe, or crumbly and flaky to the touch owing to rapid weathering. Below such places is a conspicuous layer of coarse barren *debris.*

Other cliff plants are really chasmophytes growing in deep cracks between the boulders. In such places occur, in addition to the above, *Calocephalus Brownii, Ixiolaena supina* (both confined to sea cliffs), *Frankenia pauciflora, Threlkeldia diffusa, Enchylaena tomentosa, Tetragona implexicoma, Scleranthus pungens,* and, where less exposed to spray influence, *Mesembryanthemum aequilaterale, Olearia ramulosa,* and *Rhagodia baccata.* All these must receive some direct spray in stormy weather, though, owing to the open soil and good run off, the local accumulation of salt will be slight.

On top of the sheer cliffs 200 feet high, near to the source of Main Creek, are a number of shallow depressions in the granite filled with rubble and clay (soil Sample 6). The soil analysis shows that sodium chloride is present, also a certain amount of clay, otherwise conspicuously absent in the soils. These rock basins supported little vegetation (pl. iv., fig. 2). Stunted bushes of *Arthrocnemum halocnemoides,* var. *pergranulatum,* occur, together with *Salicornia australis, Frankenia pauciflora,* and *Mesembryanthemum aequilaterale.* Around some of the basins are the prostrate trees of *Melaleuca halmaturorum* referred to earlier.

True lithophytes are certain Myxophyceae that occur by the runnels made by fresh water drainage over the bare rock slopes. These were quite dry in January, but are most noticeable as dark olive-green to black bands across the

stone. The flow of water down these channels would be very intermittent even in the wet season, owing to the small catchment and non-retentive nature of the soil covering parts of it. Scrapings of the dried algal growth showed only *Tolypothrix* sp.

Watercourses.

The two species of *Melaleuca* are the most prominent plants of watercourses on Pearson Islands. *Melaleuca parviflora* occurs along the beds of the two fresh water creeks, North Creek (pl. ix., fig. 2) and the tributary to Main Creek. It is not, of course, confined to this habitat, but when growing beside a watercourse descends further from the hills on to the plain below.

Melaleuca halmaturorum is restricted to the course of Main Creek, which it follows from source to near the mouth (pl. vi., fig. 2, and pl. vii., fig 1). This is a paper bark tea-tree, well known from habitats elsewhere in South Australia to have a high salt toleration. The water flowing down Main Creek is derived from two sources. Drainage from 781 Hill and the tors at the south-western corner of the Northern Island provides the bulk of it, but sea spray contributes some water as overflow from the granite basins described above. The upper course of the creek is indefinite and appears to be shifting. No special creek flora can be described in connection with it. The plants growing in the wide indefinite channels have been referred to under the *Pelargonium-Mesembryanthemum-Poa* community.

Drainage channels are common near to the bare granite slopes in other parts of the islands. *Ulothrix* sp. covers the soil, and growing amongst it occur such ephemerals as:—

Centrolepis sp. — *Cotula coronopifolia*
Calamgrostis filifolia

Such channels do not influence to any appreciable extent the flora of perennial plants around them.

SALTBUSH FORMATION.

Atriplex paludosum dwarf shrubland.

A typical saltbush formation is developed on several parts of Northern and Southern Islands. The principal habitat is upon the gently sloping plains that occur at the foot of the steep rocky slopes. The soil of these areas is composed of fine granitic rubble, almost sandy in texture. The free open soil is one that, in spite of its humus content, has only a low water-retaining capacity. In January many of the shrubs were obviously showing the need of water, the leaves were often flaccid, and the older ones falling off.

The temperature and insolation factors on these exposed plains must be severe. It is probable that the light grey-green colour of the *Atriplex* leaves may be correlated with light protection.

The *Atriplex* bushes stand 12 to 18 inches high, and in places form an almost closed community (pl. vi., figs. 1 and 2). Only one other plant, a small annual composite, was found on the typical saltbush plain.

Atriplex paludosum appears to be a plant that will not tolerate much moisture in the soil. Its specific name is not at all appropriate to its South Australian habitats. Depressions on the plains were colonized by *Rhagodia crassifolia* (pl. vii., fig. 1). The same plant replaces *Atriplex* at the base of the steep rocky rises above the plains, where the influence of drainage from the slopes above will be most pronounced (pl. vi., fig. 1).

It will be noticed from the analyses of soil Sample 2 (NaCl=·20 per cent.), that *Atriplex paludosum* growing on Pearson Island is not a halophyte. It was absent from the flora of the basins at the head of Main Creek, where the soil was very salt (Sample 6), though it occurred at their edges, where the salinity was even lower than in the *Atriplex* plain (Sample 5, NaCl=·15 per

cent.). The *Atriplex paludosum* association observed is a xerophytic community, not a halophytic one.

Though saltbush dwarf shrubland grows best on granitic soils, it is not confined to them. It is developed upon the higher levels of the travertine plateau on Northern Island, and at the eastern end extends almost to the coast. Exposure to sea spray is less here than on the other travertine areas. On such soils the community tends to be a mixed one, *Lycium australe, Lepidium foliosum*, and *Senecio lautus* being present. The *Atriplex* bushes are more stunted than in the pure community, with bare soil between them.

On the west side of Main Creek, *i.e.*, the dry north facing slope, patches of *Atriplex* occur as inliers in the open shrub community of *Melaleuca parviflora* described above (pl. vii., fig. 2).

Travertine Limestone Communities

It has been remarked before that the principal limestone areas can be recognized at once by the different type of vegetation that they bear. These communities are grouped together as members of a separate series. No climax is distinguished, and it is possible that were a larger series available the communities would find their place as seral units in a formation culminating either as *Atriplex* dwarf shrubland or *Melaleuca parviflora* scrub according as climatic factors were more or less xerophytic.

In regard to the travertine limestone habitat on Pearson Island, one observes that in addition to the obvious feature of calcium carbonate in the soil there must also be considered the shallow depth of soil overlying the limestone deposit, exposure to light and wind owing to the unbroken nature of the terrain, and, in some cases, *e.g.*, the soil sample analysed, No. 1, an appreciable amount of sodium chloride. In spite of these features, it is not possible to recognize such a definite limestone community as that of *Frankenia fruticulosa* seen on Franklin Island.[6] Though the travertine areas may be recognizable at once owing to the difference in the plant covering, it is less easy to define wherein that difference lies. It is usually one of degree and varying proportions of plants occurring elsewhere on the islands, rather than one due to the presence of plants limited in their distribution to these areas. Three communities are sufficiently distinct to be briefly noted:—

I. *Mat Plant Community.*

A community consisting of prostrate or semi-prostrate dwarf perennials occurs on most of the plateaux (pl. viii., fig. 2). The majority of the plants are more or less succulent, and many of them have their leaves coloured owing to the presence of anthocyanin pigments. The general effect thus produced is most striking, resembling some gigantic carpet worked in grey *(Atriplex)*, orange or red *(Mesembryanthemum)*, maroon *(Threlkeldia)*, grey-green *(Enchylaena)*, or olive-green *(Frankenia)*. The species noted are:—

Chenopodium sp. (affin. *microphyllum)*	*Atriplex cinereum*
Enchylaena tomentosa	*Mesembryanthemum australe*
Threlkeldia diffusa	*Frankenia pauciflora*

II. *Cliff Faces.*

The seaward edges of the plateaux end in low cliffs 4 to 8 feet high; at the margin of the cliff faces grow:—

Arthrocnemum halocnemoides, var. *pergranulatum*	*Suaeda australe*
	Tetragonia implexicoma
Salicornia australe	*Nitraria Schoeberi*
Enchylaena tomentosa	*Frankenia pauciflora*

(6) Osborn, T. G. B., *loc. cit.*, p. 201, 1922.

The Salicornias and *Suaeda* occupy the places most exposed to spray. Elsewhere *Nitraria* is the most important plant, often forming almost a thicket, over the bushes of which *Tetragonia* and *Enchylaena* scramble.

III. *Annual Community.*

The plant covering growing upon the plateau of Middle Pearson Island is of a type not seen elsewhere in the group (pl. ix., fig. 1). The main plants observed were:—

Lepidium foliosum	*Senecio lautus*
Apium prostratum	

Of these only the *Lepidium* was living in January. Occasional clumps of *Enchylaena*, the only perennial noted, occurred over the area.

This plateau rises steeply at the western side to the granite summit, the junction being a fan of talus from the tors above (pl. ix., fig. 1). At the junction of fan and plateau there is a belt of *Atriplex cinereum* noted above as a constituent of the travertine flora. The vegetation of the fan belongs, of course, to the mixed shrub community on granite rubble, *Olearia ramulosa* predominating.

It is very noticeable that the *Olearia* does not colonize the travertine, though it is found growing in clefts in granite exposures on either side of the plateaux.

Communities influenced by Blown Sand.

Littoral.

The only littoral plant on Pearson Island is *Atriplex cinereum*, which grows in a small patch at the north-west corner of the landing place (pl. viii., fig. 1). The habitat is one in which *Atriplex cinereum* (7) commonly occurs on the mainland, but the habit is unusual. The plant grows creeping or semi-prostrate, and so accumulates blown sand about itself through which it grows, forming mounds 2 to 3 feet high and 4 to 6 feet in diameter.

The other portions of the coast are unsuitable to the growth of flowering plants, being either boulders or platforms of bare granite often of great extent.

Blown Sand on Granite Rubble.

Behind the area mentioned above there is a trough in the granite extending inland in which wind-borne sand mingles with the rubble. *Atriplex cinereum* is replaced by *Frankenia pauciflora*, which also holds the sands, forming low mounds a foot or more in diameter; a similar growth form of this plant was observed on Franklin Island. Other plants are those of open communities influenced by sea spray; except *Lavatera plebeja*, which was seen nowhere else on the islands.

DISCUSSION.

Plant Succession.

On so small an area climatic differences are not very marked, though it is probably quite justifiable to regard the rubble plains and slopes at the foot of the hills as more arid than the hills themselves. In atmospheric humidity, intensity of insolation and temperature, if not in actual rainfall, the plains have a more xerophytic climate than the hills. It is convenient to group the succession seen on Pearson Islands into three series. The plains bear a "saltbush" flora, that of the hills falls into a *Casuarina* woodland and a shrub series culminating in *Melaleuca parviflora* scrub, and the flora on travertine limestone is the third.

(7) Osborn, T. G. B., Brit. Assocn. Report, Austr., 1914, p. 505.

There is need of further investigation of the saltbush flora in Australia, but pending the publication of further work on the subject, it may be said that saltbush is considered as essentially an arid and not a halophytic formation. A saltbush plain of the type described above is a seral unit in the formation as displayed on the mainland, but the *Atriplex paludosum* consocies on Pearson Islands is, in that locality, a subclimax. It is related to *Rhagodia crassifolia* consocies, which is the most stable community on Franklin Island. This is shown by the interesting occurrence of local patches of *Rhagodia crassifolia* in the saltbush on Pearson Islands. *Rhagodia crassifolia* open shrubland was considered a subclimax on Franklin Island, but I now regard the succession suggested, *i.e.*, towards a scrub woodland involving *Melaleuca parviflora*, as mistaken. The examination of Pearson Island shows that *Melaleuca parviflora* properly has its place in a different and less xerophytic line of succession.

The woodland series on the hill slopes shows a greater number of successional stages than the saltbush; this is to be expected in a less arid sequence. It is a formation of less xerophytic type, as is shown by the occurrence of mosses, *Cheilanthes tenuifolia* and *Calythrix tetragona*. The two last grow on the Mount Lofty Ranges in a rainfall of over 30 inches. *Casuarina stricta* consocies is a closed community at the higher levels. This species on the mainland does not form a climax associaton, but is an early stage in the sclerophyllous woodland series. *Casuarina stricta* in South Australia is characteristic of rocky outcrops, where it obtains deep but well-drained soil. On Pearson Island the forest succession goes no further than the *Casuarina* woodland, the edaphic factors as well as such a climatic factor as wind militating against the growth of most trees.

The *Melaleuca parviflora* consocies is a scrub woodland of a more xerophytic type than the *Casuarina* woodland. *Melaleuca parviflora* forms dense thickets of considerable extent on some of the neighbouring islands, *e.g.*, Flinders Island, and also on the mainland. On the mainland, however, it is certainly a stage in the sere culminating in mallee (*Eucalyptus* spp.).

The accompanying figure shows graphically the relationship between the communities on the granite slopes:—

Casuarina stricta consocies. | *Melaleuca parviflora* consocies.

Casuarina stricta with *Leucopogon*. | *Melaleuca parviflora* and mixed shrub community.

Olearia-Leucopogon **associes.** | *Melaleuca halmaturorum* consocies.

Pelargonium-Mesembryanthemum-Poa associes. | *Arthrocnemum* and dwarf halophytic communities.

Bare granite.

Fig. 2.

Diagram to show the relation of the chief scrub and woodland communities on granite.

The separation of the communities on travertine limestone into another group is a matter of convenience rather than an expression of difference. A saltbush flora develops upon travertine areas upon the mainland, for travertine limestone, of course, is not so much a geological formation as an indication of a climate with a high evaporation rate. On Pearson Island we find an open community with *Atriplex paludosum* as the dominant species upon parts of the plateaux. It is possible that some, at least, of the travertine communities should find their place in the saltbush formation, but at present it is preferable to group all the limestone communities together.

Though the main communities on Pearson Island are at present in an active state, the ultimate fate of the islands will be a bare granite reef if the present cycle of denudation continues. Middle and Southern Pearsons show no community higher than *Olearia-Leucopogon* thicket. The outlying islands appeared to have few, if any, bushes upon them. The rate of degeneration upon Northern Pearson, however, will remain slow, provided the flora is protected from malicious fires.

Flora.

A complete list of the vascular plants collected is given in Appendix II. It comprises 52 species, though, as the islands were visited in the dry season, the list is probably incomplete as far as herbaceous plants are concerned. The most important families are: Chenopodiaceae (10 species), Compositae (9 species), and Gramineae (5 species).

No member of the Leguminoseae was found on the islands. None were found in the flora of Franklin Island.[8] Considering that the Leguminoseae is the family represented by the greatest number of species in the Australian Flora,[9] its apparent absence is remarkable.

The Myrtaceae are represented by three species, but no Eucalypt is present. This, again, is a surprising feature, for mallee Eucalypts occur on the coast of the neighbouring mainland.

The Centrolepis appears to be new, but it was obtained with fruits only. An attempt is being made to raise it from seed, and, if successful, the plant will be described later by Mr. J. M. Black.

In the list given below the growth forms according to Raunkaier's system are also stated. There are three species of low trees (Microphanaerophytes, 5·7 per cent.) and 19 species of shrubs (Nanophanaerophytes 36 per cent.), making altogether a phanaerophyte flora of 41·7 per cent. This is very nearly the phanaerophyte percentage for the normal spectrum (43 per cent.), but there are no other trees than microphanaerophytes and there is an overwhelming preponderance of shrubs.

District.	Total number of Species considered.	Percentage of Species belonging to each Life Form.									
		MM.	M.	N.	Ch.	H.	G.	HH.	Th.	E.	S.
Pearson Island ..	53	—	5·7	36	28·3	1·9	—	—	28·2	—	—
Franklin Island .	34*	—	—	15	38	—	—	—	47	—	—
Ooldea	188	·5	19	23	14	4	·5	—	35	4†	—
Natal	3,034	3	14	14	19	18	18	5·5	6·5	1	1
Normal Spectrum	400	6	17	20	9	27	3	1	13	3	1

The number of dwarf shrubs or herbaceous perennials is 15. These have no special protection for their buds, but are mat plants, cushion plants, or grow in tussocks (Chamaephytes 28·2 per cent.). The percentage is more than three times that of the normal spectrum. On the Franklin Islands the percentage was even higher. This may partly be attributed to the rather special habitat in wind-swept islands, but there may be other reasons. When examining the arid type of flora at Ooldea, Adamson and the writer [10] found a rather high percentage

*The total number of species is so small that the percentages may be misleading unless taken in a general way as emphasising the abundance of chamaephytes and therophytes and the absence of most of the other life forms.

† The epiphytes here were hemiparasites, very prominent in arid districts of South Australia, for which no provision is made by Raunkaier's system.

(8) Osborn, T. G. B., *loc. cit.*, p. 204, 1922.

(9) Maiden, J. H., Australian Vegetation, Federal Handbook on Australia, p. 166, 1914.

(10) Adamson, R. S., and Osborn, T. G. B., On the Ecology of the Ooldea District, Trans. Roy. Soc. S. Austr., xlvi., p. 558, 1922.

of Chamaephytes (14·1), and Bews[11] in the Flora of Natal notes the same thing (19 per cent.). Raunkaier has shown that Chamaephytes increase towards the polar regions and also in hot climates with a dry season. Even allowing for the fact that the Pearson Islands have a restricted flora and a special type of habitat, the relatively large number of Chamaephytes is a feature of the flora that agrees with the few other biological spectra that have been published for Southern Hemisphere floras. The Chamaephyte protects its buds by the shelter of the plant itself or its dead remains heaped around them. These persistent aerial portions also serve as a break that arrests movement of unstable soil. In the case of Hemicryptophytes protection is gained as a result of the subterranean position of the renewal buds which lie in the upper crust of the soil. This method is less suitable for unstable soil, which may "drift," exposing the buds. Also, in dry weather the dead remains are likely to be blown away instead of remaining heaped over the buried portions. It must be remembered that in South Australia the adverse period is a time of drought and heat, not cold.

Hemicryptophytes (H) are represented on the Pearson Islands by a single species, the fern *Cheilanthes tenuifolia* (H, 1·9 per cent.). None were found on Franklin Island and only 4 per cent. at Ooldea. This rarity of Hemicryptophytes in the floras of the three arid districts of Australia, which have up to the present been investigated on Raunkaier's system, is a feature requiring further examination.

No geophytes were observed. This may be due to the season of the year, but it may be recalled that only a single species was observed at Ooldea in the winter months.

The therophyte flora (Th, 28·2 per cent.) is less than that at Ooldea or Franklin Islands, but the percentage is still double that of the normal spectrum. It is probable that the number of annual species would be increased were it possible to visit the islands during the wet season, though comparisons with Franklin Islands are quite justifiable since those islands were also visited in January. Probably the percentage of therophytes on Pearson Islands is less than that of the other two districts because, owing to the topography of the islands, denudation is more rapid and the soil correspondingly less stable.

Appendix I.

ANALYSES OF SOIL SAMPLES FROM PEARSON ISLANDS

By J. G. Wood, B.Sc.

The samples were all obtained from a section through the first 4 to 6 inches of the soil after brushing away the surface layer. They were, all but No. 1, derived from granite, and are of the "coarse sand" type, *i.e.*, the majority of the particles have a diameter of from 1 to 0·2 mm., and consequently the soils have little water-holding capacity. This is modified in the case of soil No. 6, which has a considerable amount of clay, and also in Nos. 2 and 3, which have 9·9 per cent. and 13·9 per cent. of humus, respectively.

Before analysis the soils were air-dried and then passed through a 10-mesh (2·6 mm.) sieve, and the sieved soil was finely ground and used for analysis. The screenings consisted of fragments of granite, felspar, quartz, and in some cases (mentioned below) dried vegetation as twigs, roots, etc., and also droppings from cockroaches. The screenings in each case amounted to about one-third of the total sample of soil.

The results of the analyses are set forth in the table:—

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[11] Bews, J. W., The growth forms of Natal Plants, Trans. Roy. Soc. S. Africa, v., p. 624, 1916.

No.	ZONE	Description	Water at 100°c %	Combined Water	Humus	Total Chlorine	Sodium Chloride	Total Salts	Carbon Dioxide	Calcium Carbonate	Nitrogen	pH.
1	*Mesembryanthemum australe,* with *Atriplex cinereum,* from Travertine plateau. Southern Pearson	Coarse granite sand with twigs and dung	2·1	—	9·0 after allowing for twigs 6·0	·18	·79	—	4 3	9 7	·38	8 0
2	*Atriplex paludosum,* Southern Pearson	Coarse granite sand with twigs and dung	2 2	—	12·9 after allowing for twigs 9·9	·12	·20	—	Nil	Nil	·40	7·4
3	*Casuarina* woodland, well up slope but below *Cheilanthes* zone (*Casuarina* and *Leucopogon*)	Coarse sand with dark humus and dung	1·8	—	13·9	·14	·23	—	Nil	Nil	·50	6·0
4	Head of creek with *Scleranthus, Poa,* and *Mesem. aequilaterale*	Granite sand, no twigs nor dung	6	—	3·1	·04	·06	—	Nil	Nil	·09	7·2
5	*Atriplex paludosum* at rim of basin	Granite sand with no twigs, more humus and less dung	1·1	—	6·5	·09	·15	—	Nil	Nil	·24	7·0
6	Basin at head of creek, with *Arthrocnemum* and wind-blown *Melaleuca*	Granite sand with clay, no twigs nor dung	4·5	3 0	3·8	1 87	3·08	3 4	Nil	Nil	·07	7·4

Little need be said regarding the moisture at 100° C. This is low, as would be expected of coarse sands, and the range is small between the different samples. The water-retaining-capacity factor alone appears to influence the plant distribution very slightly. The highest percentage of water is reached in the case of soil No. 6, obtained from the basin at the head of the creek. It contains more clay than the other soils, the felspar being largely kaolinized

The presence of clay (hydrous silicate of alumina) is reflected also in the second column (combined water) Rough estimations showed that the combined water was practically nil in all cases except in soil No. 6, where it was determined. It amounted to 3 per cent.

The column headed "humus" was determined by the loss on ignition after deducting the CO_2 and the total water content, which gives approximately the percentage of humus. This is complicated in the case of soils Nos. 1 and 2 by the fact that a good deal of dried undecomposed plant *debris* (twigs and portions of roots) passed through the sieve. To determine these the soils were shaken with water, when most of the small twigs floated to the top. These were collected and dried, and were found to amount to about 3 per cent. in each case. They do not, however, alter the relative positions of the soils in regard to humus content. Soil No. 3 is a dark soil from the *Casuarina* woodland zone containing 13·9 per cent. of humus and comparatively free from small twigs. As one usually finds in woodland soils, it contains an acid humus, as is shown in the pH value in the last column in the table. This soil forms a notable contrast with soil No. 2, with which it is practically identical in composition, except that the humus content is about 4 per cent lower in No. 2 (taking the twigs into account).

No. 2 soil is not acid, however, but on the alkaline side of neutrality (neutrality pH=7·0). It appears possible that the reaction of the soil may be one of the factors influencing the type of flora, for whilst the acid soil supports *Casuarina* and *Leucopogon*, the alkaline one is covered with *Atriplex*. In soil No. 5 the organic matter is well decomposed and contains no twigs. It approximates soil No. 2 in composition, though it is poorer in humus. Soil No. 4 is very deficient in organic matter. It is a typical barren granitic soil.

The fourth column gives the percentage of chlorine, and the next these percentages calculated as sodium chloride. There is practically no K Cl present, the potassium which is present being combined with aluminium silicate in the clay. A determination of the total soluble salts in soil No. 6 showed that these amounted to 3·4 per cent., and of this 3·08 per cent. was Na Cl, as calculated from the chlorine content. There was very little potassium present. The salt is derived from sea spray, and the analyses show that two soils, Nos. 1 and 6, have abnormally high percentages.

The most interesting feature brought out in connection with the salt content is the range of *Atriplex*, which is usually classed as a halophyte. In Nos. 2 and 5, with an average soil saline content, *A. paludosum* thrives, while *A. cinereum* tolerates 0·97 Na Cl. In soil No. 6, where the salt content is high (due to accumulation by evaporation of sea water in the basin), *Atriplex* is absent. The characteristic vegetation is *Arthrocnemum halocnemoides*, var. *pergranulatum*, and *Melaleuca halmaturorum*.

The presence of *Atriplex* spp. in the areas of low salt concentration, and their absence from soils with a high percentage of sodium chloride, supports the objection that has been made to classing the "saltbushes" of Australia as halophytes.[12]

The carbonate content calls for no comment here; calcium carbonate is present only in the soil from the travertine plateau.

[12] Adamson and Osborn, Trans. Roy Soc. S. Austr., xlvi. (1922), p. 544.

As regards nitrogen, soils Nos. 4 and 6 only show the amount which one would expect from soils of this type (*i.e.*, around 0·1 per cent). The other soils are high. This is accounted for by the large amounts of droppings from the cockroaches before mentioned. The screenings of Nos. 1, 2, and 3 particularly had large amounts of dung, while it was less evident in Soil No. 5. This "manuring" must appreciably affect the luxuriance of growth. Unfortunately, no two soils taken resemble one another in all save nitrogen content, so one cannot make a quantitative camparison.

In the last column are given the pH values of the soils. These were determined colorimetrically, using Clark and Lub's series of indicators.[13] They bear out one's expectations. The forest soil, with high humus content and exposed to wind,[14] is acidic, while the limestone soil is alkaline. The other granite soils are also slightly on the alkaline side. This latter feature was not unexpected, although granite soils, as a class, when not near the sea are slightly acidic. On the island, however, the soils can all be reached by sea spray (either by dashing on rocks or carried by wind), and sea water itself has a pH of about 8·2, due mainly to magnesium and calcium salts. It is probably this fact which brings the reaction from slight acidity to slight alkalinity. The possible correlation between the vegetation and these values has been mentioned under "humus."

Appendix II.

LIST OF SPECIES COLLECTED.

Following is a list of the species collected on Pearson Island. I am grateful to Mr. J. M. Black for kindly examining my collection and determining some of the plants. The Centrolepis will be described by him later

In addition to the name of the plant and its growth form according to Raunkaier's system, notes on the habit are given and the community in which it occurs. The habit notes, leaf measurements, etc., refer to Pearson Island specimens:—

[13] Clark, Determination of Hydrogen Ions, 1920

[14] Warming, Oecology of Plants, p. 62.

Name.	Raunkaier's Class.	Habit.	Community
POLYPODIACEAE.			
***Cheilanthes tenuifolia*, Schw.**	H.	Small tufted fern	*Casuarina stricta* consocies
GRAMINEAE.			
***Calamagrostis filifolia*, (Forst.) Pilger**	Th.	Small tufted grass	" "
***Danthonia penicillata*, (Labill.) F. v. M.**	Th.	" "	" "
***Poa caespitosa*, var. *Billardierii*, Hook. f.**	Ch.	Pungent leaved tussock grass, leaves up to 30 cms.	*Pelargonium-Mesembryanthemum-Poa* associes
Festuca bromoides, L.	Th.	Small annual grass	*Casuarina stricta* consocies
Agropyrum scabrum, (Labill.) Beauv.	Th.	" "	" "
LILIACEAE.			
Dianella revoluta, R. Br.	Ch.	Tussock plant with revolute leaves 40-50 cms. long	*Pelargonium-Mesembryanthemum-Poa* associes
Bulbine semi-barbata, (R. Br.) Haw.	Th.	Dwarf herb	*Olearia-Leucopogon* associes
CENTROLEPIDIACEAE.			
Centrolepis sp.	Th.	Minute tufted herb	Fresh water swampy drainage channels
CASUARINACEAE.			
Casuarina stricta, Ait.	M.	Tree up to 6-9 m.	Dominant on hill summits
CHENOPODIACEAE.			
Rhagodia baccata, Moq.	N.	Shrub, up to 2 m, often scrambling habit	Cliffs, *Olearia-Leucopogon* associes, river bed
R. crassifolia, R. Br.	N.	Shrub 1 m. or less, erect or spreading	Hollows in *Atriplex paludosum* consocies; bare rubble with water at some depth
Chenopodium sp. (*affin., microphyllum*)	Th.	Herbaceous mat plant	Sea cliff; travertine plateau
Atriplex cinereum, Poir.	Ch	Prostrate, half shrubby	Travertine plateaux; littoral
A. paludosum, R. Br.	N.	Erect bushy shrub	*Atriplex paludosum* consocies
Enchylaena tomentosa, R. Br.	N	Semi-prostrate and dense or scrambling shrub, leaves succulent	Travertine plateaux; sea cliffs
Threlkeldia diffusa, R. Br.	Ch.	Succulent leaved mat plant	" " "
Arthrocnemum halocnemoides, Nees, var. *pergranulatum*, J. M. B.	N.	Divaricating succulent low shrub, 5 m.	Cliffs near sea; salt basins in granite at about 200 feet altitude
Salicornia australis, Sol.	Ch.	Prostrate, half shrubby	Near sea
Suaeda australis, Moq.	Ch.	Succulent, mat plant, base woody	Cliffs near sea, spray washed

Name.	Raunkaier's Class.	Habit.	Community.
AIZOACEAE.			
Tetragonia implexicoma, Hook.	N.	Scrambling weak shrub, leaves succulent with small epidermal bladders. 2 to 2·5 x ·2 to ·4 cms.	Mixed scrub; travertine cliffs
Mesembryanthemum aequilaterale, Haw.	Ch.	Mat plant with very succulent erect leaves, 7 to 8 cms.	Early colonist of rubble, not halophytic
M. australe, Sol.	Ch.	As above, leaves often coloured orange or red, 1 to 2·5 cms.	Travertine plateaux; sea cliffs
CARYOPHYLLACEAE.			
Scleranthus pungens, R. Br.	Ch.	Cushion plant, up to 50 cms. diameter	*Pelargonium-Mesembryanthemum-Poa* associes; cliffs and exposed slopes
CRUCIFERAE.			
Lepidium foliosum, Desv.	Th.	Erect branching annual, up to 1 m. high	Travertine plateau; *Olearia-Leucopogon* associes
GERANIACEAE.			
Pelargonium australe, Willd.	Ch	Low fleshy stemmed, velvety hairy, especially underside leaves	Early colonist of rubble
ZYGOPHYLLACEAE.			
Nitraria Schoeberi, L.	N.	Fleshy leaved shrub under 1·5 m.	Travertine cliffs
RUTACEAE.			
Correa speciosa, Andrews	N.	Shrub up to 1 m., leaves ovate 2 to 2·5 x 1 to 1·8 cms., tough, tomentose below	*Olearia-Leucopogon* associes
SAPINDACEAE.			
Dodonaea viscosa, L.	N.	Erect shrub up to 2 m., leaves 4 to 5 x 1 cms., thin, tough, sticky lacquered	*Melaleuca parviflora* scrub
RHAMNACEAE.			
Spyridium eriocephalum, Fenzl.	N.	Low, peely branching shrub, 5 m., leaves ·6 to 1·2 x ·15 cms., revolute	*Casuarina stricta* associes *Melaleuca parviflora* scrub
MALVACEAE.			
Lavatera plebeja, Sims, var. *tomentosa*, Hook.	Th.	Erect annual, 40 cms.	Rubble and sand
FRANKENIACEAE.			
Frankenia pauciflora, D.C.	Ch.	Semi-prostrate shrub, leaves up to 1 cm., linear, revolute	Travertine plateau; blown sand
THYMELIACEAE.			
Pimelia serpyllifolia, R. Br.	N.	Erect shrub, 1 m., densely branching, leaves ovate-oblong 6 to 8 x 2 to 4 cms.	*Melaleuca parviflora* scrub

Name.	Raunkaier's Class.	Habit.	Community.
MYRTACEAE.			
Melaleuca parviflora, Lindl.	M.	Small tree, dense canopy, leaves linear, ·6 to ·8 cms., bark rough	Lower hill slopes, scrub woodland; fresh watercourses
M. halmaturorum, F. v. M.	M.	Small tree, dense canopy, leaves linear, ·6 to 8 cms., bark papery	Brackish watercourse
Calythrix teragona, Labill.	N.	Erect shrub, leaves linear, ·8 x ·1 cms.	*Casuarina stricta* consocies
UMBELLIFERAE.			
Apium prostratum, Labill.	Th.	Prostrate herb forming dense mat	Travertine plateau
Didiscus pusillus, F. v. M.	Th.	Erect small herb	*Casuarina stricta* consocies
EPACRIDACEAE.			
Leucopogon Richei, Labill.	N.	Bushy shrub up to ·5 m., leaves ovate lanceolate ·8 to 1 x 2 cms.	Shrub community; undershrub in *Casuarina* woodland
LABIATAE.			
Westringia rigida, R. Br., var. *dolichophylla*, Ostenf.	N.	Erect branching shrub, 70 cms., leaves linear 2 x ·15 cms., somewhat revolute	*Melaleuca parviflora* scrub
SOLANACEAE.			
Lycium australe, F. v. M.	N.	Erect bushy shrub, branches spinescent, leaves on dwarf shoots 1 to 1·5 x ·2 to ·5 cms., many shed in dry season	Saltbush community on travertine plateau
Nicotiana suaveolens, Lehm.	Th.	Rosette plant	Rubble or sand
MYOPORACEAE.			
Myoporum insulare, R. Br.	N.	Spreading bush up to 1·5 m., leaves 8-10 cms., fleshy	*Olearia-Leucopogon* associes
M. deserti, A. Cunn.	N.	Erect shrub, 70 cms., leaves 2 to 4 cms., prominently glandular	*Melaleuca parviflora* scrub
COMPOSITAE.			
Olearia ramulosa, Labill.	N.	Erect bushy shrub, up to 1·5 m., leaves ·8 to 1 x 1 cms., revolute woolly below	Shrub community
Cotula coronopifolia, L.	Th.	Small herb	Swampy fresh watercourses
Ixiolaena supina, F. v. M.	Ch.	Prostrate, half shrub, old leaves fleshy	Sea cliffs
Cassinia spectabilis, R. Br.	Ch.	Erect robust herb, leaves lanceolate 3 to 10 x 1 to 3 cms.	*Casuarina stricta* consocies
Calocephalus Brownii, F. v. M.	N.	Divaricating shrub, white tomentum, leaves 3 mm erect	Sea cliffs
Senecio lautus, Sol.	Th.	Erect branching herb	Travertine sandy rubble
S. Cunninghamii, DC.	Ch.	Erect branching herb, woody base, leaves 8 to 12 x 8 to 1·2 cms	*Casuarina stricta* consocies
Sonchus asper, All., var. *littoralis*, J. M. B.	Th.	Fleshy-leaved herb	Sandy rubble near shore

DESCRIPTION OF PLATES.

PLATE IV.

Fig. 1. View of East Hill looking east along the col from the slope of 781 Hill. The north face (left) has a shrub flora and much bare rock, while the south face has a covering of low trees of *Casuarina stricta* and *Melaleuca parviflora*. The trees in the foreground are Casuarinas.

Fig. 2. 781 Hill from south looking across a granite basin at the head of Main Creek. The vegetation in the foreground is *Arthrocnemum halocnemoides*, var. *pergranulatum*, and *Mesembryanthemum australe*. Immediately behind the basin are prostrate trees of *Melaleuca halmaturorum*. Beyond is a scrub woodland of *Melaleuca parviflora*, passing into *Casuarina stricta* woodland about half-way to the summit. The slopes of 781 Hill show the characteristic areas of bare granite.

PLATE V.

Fig. 1 *Casuarina stricta* woodland with undergrowth of *Leucopogon Richei*. To the right is the edge of one of the bare granite areas. South face of 781 Hill.

Fig. 2 Summit of East Hill from the north side of col. *Casuarina stricta* on summit amongst granite tors, with *Melaleuca parviflora, Olearia ramulosa*, and *Leucopogon Richei* as shrubs. The Casuarinas disappear about the level of the large tor right of the middle. The shrubs in the foreground are *Rhagodia crassifolia*.

PLATE VI.

Fig. 1. *Atriplex paludosum* consocies on rubble plain, showing in middle distance sharp junction with community composed of *Rhagodia crassifolia* at the base of a steep rise About the level of the granite boulders *Rhagodia* is replaced by the *Olearia-Leucopogon* thicket community. On the skyline a few trees of *Casuarina* and *Melaleuca parviflora*. South slope of East Hill, Northern Pearson.

Fig. 2. *Atriplex paludosum* consocies in foreground; behind is the lower course of Main Creek, with a dense scrub of *Melaleuca halmaturorum*, the "paper bark" of which makes the trunks appear white. In the background is the south-east face of 781 Hill, with scrub woodland of *Melaleuca parviflora* on the lower slopes and *Casuarina stricta* in the upper part. Note the large areas of bare granite on 781 Hill.

PLATE VII.

Fig 1. *Atriplex paludosum* consocies on rubble plain with local patches of *Rhagodia crassifolia* (darker-coloured foliage) in hollows. Beyond is the course of Main Creek, with *Melaleuca halmaturorum* intersecting a scrub in which *Melaleuca parviflora* is dominant. The tors on the skyline, right, are at the south-west corner of Northern Pearson.

Fig. 2. *Melaleuca parviflora* scrub and *Atriplex paludosum* consocies junction on north bank of Main Creek. Note the patches of *Mesembryanthemum aequilaterale* with *Pelargonium australe*, the first colonists of granite rubble in the scrub woodland series.

PLATE VIII.

Fig. 1. *Atriplex cinereum* on shore forming mounds of blown sand. Behind *Frankenia pauciflora*, dark leaves, also holds sand. Higher up the slope mixed communities, including *Lepidium foliosum* and *Olearia ramulosa*. In right hand corner portions of two hair seals (*Arctocephalus fosteri*) can be seen.

Fig. 2. Foreground travertine plateau flora on Southern Pearson; plants, *Atriplex cinereum, Mesembryanthemum australe, Threlkeldia, Enchylaena*, etc. Middle Pearson, with the landing place seen behind—note the abrupt (south-west) face and gentle slope of the east side. The travertine plateau of this island is well seen. To the right is the south-west coast of Northern Island, with 781 and North Hills.

PLATE IX.

Fig. 1. Annual plants (*Senecio lautus* and *Apium prostratum*) now dead and *Enchylaena tomentosa* on travertine plateau of Middle Pearson. Behind Junction of talus slope with *Olearia-Leucopogon* thicket on boulder slope.

Fig. 2. Foreground *Atriplex paludosum* on talus slope to North Bay, Northern Pearson. A watercourse runs from right to left marked by occasional bushes of *Melaleuca parviflora*. This watercourse (North Creek) is fresh. Beyond is bare talus with large spreading bushes of *Rhagodia crassifolia*. The rocky slope behind has an open shrubby flora, chiefly *Olearia ramulosa, Rhagodia baccata*, with some *Leucopogon Richei, Correa speciosa, Mesem. aequilaterale*, and *Pelargonium* on exposed parts with *Scleranthus pungens* and *Poa*.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 9.—THE BIRDS OF THE PEARSON ISLANDS.

By J. Burton Cleland, M.D.

[Read May 10, 1923.]

Considerable interest is attached to the consideration of the land birds inhabiting an island constituted and situated as is Pearson Island. The interest is the same as that attendant on the study of the local faunas of Tasmania and of the islands in Bass Straits. At one time, these were all obviously connected with the adjacent mainland. The group comprising the Pearson Islands now forms the remaining southern outlier of a submerged part of the continent, being distant about 42 miles from the mainland and half this distance from Flinders Island interposed between. Some, all, or none of the land birds now on this group of islands may represent the descendants of those species left behind when the separation occurred. As often happens under such circumstances, some of the species thus left, if still represented by living forms, might be expected to show some tangible subspecific, if not specific, differences from those on the mainland. Professor Wood Jones' expedition in January, 1923, hoped to obtain a sufficient collection of skins to ascertain whether any such differences existed. Further, it might happen that some species, now extinct on the mainland, still survived on this lonely group.

Previous visitors to the Pearson Islands have left little record of the birds they observed. Flinders sighted and named the islands, but did not approach near to them. In the sailing directions given in the Australia Directory (10th edit., vol. i., 1907), it is stated that large flocks of Albatrosses may be seen in its vicinity. The "albatrosses"' referred to seem to be the Pacific Gulls. Mr. Edgar Waite, visiting the island for a few hours on September 27, 1914, noted the presence of Cape Barren Geese, Black Oyster-catchers, Little Penguins, Pacific Gulls, Parrots, *Zosterops*, a Thickhead, and Crows, but did not publish his observations. Professor Wood Jones on two recent short visits saw, besides Crested Terns, Silver and Pacific Gulls, Blue Reef-Herons, Cape Barren Geese, Rock-Parrots, and Crows, and what he believed to be several large Green Parrots. No sign of these latter were detected during our stay.

The birds of the island naturally divide themselves into the sea birds, including all those birds that live in the immediate neighbourhood of our coasts, and the land birds proper. Of the former, with one exception, nothing of particular interest was observed. The exception consisted in the presence on the island of a pair of Red-tailed Tropic Birds, a species hitherto represented in South Australian waters by only one specimen—a female secured on January 13, 1919, which had been flying about Grantala Farm, North Shields, near Port Lincoln, for a week and had been captured alive. This was presented to the South Australian Museum. A taxidermist's note states that, on skinning, the bird was "found to have no ears."

There are three ways in which the presence of land birds may be explained on the Pearson Islands. They may be descendants of the birds originally left there when the islands were separated from the mainland; they may represent birds blown out to sea by strong winds, especially north winds; or they may be birds that have deliberately flown south into the Bight and have here made land.

The species met with on the islands are not peculiar to it. No sound subspecies can be differentiated. We have not then this guide, namely, differentia-

tion—a process taking a long period of time to bring about—to aid us in deciding whether any species is autochthonous or not; even had such changes occurred, these might have been in the descendants of an early immigrant. Is there anything else that may help us in deciding? We may possibly get some help by ascertaining whether the species of land birds present also occur on the adjacent mainland, and, if so, whether they are numerous there and what are their habits. If an island species is not present on the mainland, we may infer that the species is autochthonous or an early immigrant, *i.e.*, an immigrant at a period when the species also occurred on the mainland, though it had since died out Again, if the species in question is relatively rare on the adjacent coast, if it does not congregate in little flocks, and if in its habits it is disinclined to fly across open spaces and so be caught by a strong wind and blown to sea, then there is little likelihood of an individual becoming an unwilling immigrant to this distant island, and still less likelihood of a pair of birds, of opposite sexes, reaching it within a year or so of each other so as to mate and have offspring. Unfortunately a consideration of these several aspects still leaves the matter open.

In October, 1909, members of the Australasian Ornithologists' Union visited Eyre Peninsula and held a camp at Wanilla, some 50 miles north-west of Port Lincoln. From here excursions were made as far as the south-east end of the Great Australian Bight. The birds noted are recorded by Hall (The Emu, ix., 1909-10, p. 123). In this list appear the Raven *(Corone australis)*, the Red-cap Robin, *Ephthianura albifrons*, *Pachycephala pectoralis*, Welcome Swallow, *Zosterops*, three species of Wood-Swallows, *Neophema petrophila*, Starlings, and Sparrows. A Bronze Cuckoo does not appear, but its omission does not mean that it does not occur. We thus see that the birds found on the islands occur on the mainland nearly opposite, assuming that the Wood-Swallow seen belongs to one of the three species noted (if so, *Artamus personatus)*.

Let us consider these birds in detail. The Crow, or Raven, is a powerful flier, and might possibly deliberately visit the island and, at any rate, might easily be blown there. *Zosterops* frequently congregates in little flocks, and these may traverse open spaces. Flocks might thus be easily blown to sea, and the sudden irruption of these birds in New Zealand a number of years ago is believed by many to have been due to a flock having thus been wind-borne. At Willis Island, in the Coral Sea, about 250 miles from Cairns, two birds, believed from the description to be *Zosterops* (The Emu, xxii., January, 1923, p. 186), are recorded as "strangers." *Zosterops* may thus be taken to be a bird liable in its habits to be blown to sea and to survive over long stretches of ocean. With strong north and north-east winds it might easily, therefore, from time to time be blown from its feeding haunts near open coasts to the Pearson Islands. If any of the present birds can claim to be descendants of individauls left behind originally, it may safely be assumed that over the centuries this blood has been diluted again and again by new arrivals.

Ephthianura albifrons was one of the commonest birds on the islands. Its tendency to inhabit open spaces, often near the sea, covered with low shrubs such as samphire, and its congregation into small flocks, would render it, like *Zosterops*, liable to being frequently blown to sea.

Welcome Swallows, besides frequenting the neighbourhood of human dwellings, caves, and overhanging rocks, are also found on rocky coasts, such as those west of Rosetta Head, at Encounter Bay. In such situations they doubtless find suitable nesting sites in the breeding season. On Pearson Islands they were seen on a similar rocky coast and flying to and fro amongst overhanging masses of granite near the highest point on the main island. Their powers of flight and frequent coast habitat account for their presence.

The occurrence of the Rock Parrot can be easily explained, considering its habits, which expose it to the perils of the winds. Hunger may have, at times, compelled a flight from other islands, and the Pearson Islands may have served as a haven of refuge.

The Starlings, believed to have been seen, and the very doubtful presence of Sparrows, can only be explained by wind dispersal. Starlings would hardly seek deliberately such a far-distant speck of land for food.

The habits of *Artamus personatus*, which in numbers at certain seasons soar often to great heights into the air, would render these birds liable to accidental transport. The presence of a pair only would suggest that the passage had been a dangerous one and few had survived, or that a suitable insect food supply was insufficiently abundant.

We are left with the Red-cap Robin and the *Pachycephala*. I will deal separately with the Bronze Cuckoo as coming in a category by itself. Red-cap Robins are doubtless relatively numerous on the adjacent coast. They usually occur, however, in pairs, though occasionally two full-plumaged cocks and several dull-coloured birds may be seen in company. Their daintiness does not suggest strong powers of flight. Doubtless an occasional bird is blown to sea, very rarely two may be, and make the same haven, Pearson Islands. The chances would be doubled against the two birds being mates. The origin of the birds now present must be left entirely open, though I incline to the immigrant view.

Pachycephala pectoralis remains. It occurs on the mainland. Whether numerous there, I know not; but in my experience in other parts I would expect it to be, though not rare, by no means numerous—a pair of birds, say, to some square miles of country. Here, it seems to me, the chances are decidedly against two birds of opposite sexes making this island within a year or so of each other. *Pachycephala* may be an autochthone.

The presence of a Bronze Cuckoo, of which species two birds at least were seen and one was secured, was a surprise. These birds are migratory, at least in many parts of Australia, though North (Nests and Eggs, iii., p. 23) states that *Chalcococcyx basalis* may be a permanent resident of the Sydney district. In the Adelaide district they are numerous in the spring and early summer. Whither they migrate is unexplained. Mathews (Birds of Australia, vii., p. 345) suggests, into the interior of Australia, though the species has an extra-Australian range. The important point to consider in connection with the species is that it is migratory, at least in places, such as southern South Australia, Victoria, and Tasmania. Are we to consider the birds found on Pearson Islands as migrants or as stationary individuals, such as may be the case amongst some in the Sydney area? If the climatic conditions in other parts of South Australia do not entice these birds to remain all the year round, it does not seem to me likely that the Pearson Islands would do so. If the birds deliberately migrated there, there would be no reason why they might not return north equally well. Such a migration and return occur in Tasmania. I think we may assume that the Pearson Island birds are as much migrants as Tasmanian ones. Does their occurrence on the Pearson Islands then indicate that many birds, on reaching the shores of the Bight, proceed on south, though islands are few—mere specks in the ocean—and many must perish, the only survivors probably of those that leave the immediate vicinity of the mainland being the Pearson Island ones? I think this view is quite a likely one. But why do they pass on south? It is perhaps too much to surmise that they seek a land which is now submerged, that part of southern Australia that originally reached as far as the Pearson Islands and beyond them till the limits of the continental shelf are reached. This would presuppose that the instinct, directing them to a particular area, had remained unabated and unmodified by changed

geographical conditions over a period of time to be counted in thousands of years.

Eudyptula minor (Forst.) (Little Penguin). Young birds, still with some down on the feathers, were numerous under the rocks and in the midst of tangled masses of low shrubs. It is interesting to note the height above the water and the distance from the sea to which the adult birds travel to lay their eggs. A number of dead Penguins were found amongst the shrubs, but the cause of their death was not ascertained. Towards dusk, the young birds often uttered their peculiar squeaks and were frequently to be seen emerging from their recesses and standing up surveying their surroundings, but within easy distance of their retreats. It was a surprise to find that the only hair seal killed (for scientific purposes) showed an absence of fish in its stomach, but numerous half-grown Penguin's feathers and other evidence of these birds forming its staple, if not entire, diet at this time of year. A young Penguin caught had a rectal temperature of 40° C. Ticks (probably *Ixodes percavatus,* Neum.) were present on it.

Sterna bergi, Lichten. (Crested Tern). Fairly numerous. Male bird secured; iris dark brown; bill greenish-yellow; tongue more of a maize-yellow; legs black. Total length to tips of bifurcations of wings, 44 cm. Span across outspread wings, 92 cm. T., 39·3° C. Mallophaga present; mites on wings; cestodes in intestine. Several small fish in stomach.

Larus novae-hollandiae, Steph. (Silver Gull). Numerous.

Gabianus pacificus (Lath.) (Pacific Gull). A number of these handsome birds, mostly in adult plumage, were present. The reference to large flocks of "albatrosses" in the description of the Pearson Islands given in the "Australia Directory" (1907, vol. i.) unquestionably refers to this species. Professor Wood Jones found a nest here with two eggs on November 25, 1920. A full-plumaged female bird, in attempting to steal a bait, got entangled in a fishing line that had been temporarily left unattended. Iris, white; eyelid, orange; base of bill, chrome; distal third of bill, red with dark grey along the cutting edge; inside of bill, chrome; tongue and floor of mouth between rami of lower bill, orange; gape, orange, except for a narrow chrome-coloured outer edge; legs, maize-yellow. Total length, 58·4 cm. Span across outspread wings, 134 cm. T., 40° C. Mites on wings. No entozoa detected. Stomach contents, part of a rock crab.

Haematopus unicolor, Wagler (Black Oyster-catcher). Several pairs of these birds were present. One pair in particular returned again and again to a particular spot amongst granite boulders and bare ground as if a nest were in the neighbourhood, but none was found. One bird, a male, was secured; iris, crimson; eyelid, orange; base of bill, orange like the eyelid passing into pinkish-orange in the distal half; inside of bill, orange; pharynx, flesh coloured; legs, lilac; toes, maize-yellow. Total length, 52 cm. Span of outspread wings, 91 cm.; weight, 652 grms. (1 lb. 7 ozs.). T., *per cloacam,* 41° C.; by stomach, 40·6° C. Mallophaga present; cestodes in alimentary tract.

Lobibyx novae-hollandiae (Steph.) (Spurwing Plover). Three were seen on the southern part of the island and again on the northern extremity.

Notophoyx novae-hollandiae (Lath.) (White-faced Heron). A few birds were present.

Demigretta sacra (Gmel.) (Blue Reef-Heron). Seen by some members of the party.

Cereopsis novae-hollandiae, Lath. (Cape Barren Goose). Three of these fine birds were seen flying around the bay as the landing was made, and again on several occasions during our stay.

Phalacrocorax carbo (L.) (Black Cormorant). A few present.

Phaethon rubricaudus, Boll. (Red-tailed Tropic Bird). The presence of a pair of "Bo's'n Birds" on Pearson Island was a surprise to members of the party, most of whom had an opportunity of seeing one at least of them. They circled round the summit of the north part and occasionally descended to the flatter portion on the east. Two members saw one within easy gun-shot (about 30 yards off) flying low over the tea-tree. As it did so, it suddenly dropped the beautiful red tail feathers, suggesting to one of the two, who had not previously seen a Tropic Bird, that it was passing red dejecta. The bird flew in a straight line flapping its wings. It was thought at the time that this would prove to be a new record for the State, but, as already mentioned, there is in the South Australian Museum the skin of a Red-tailed Tropic Bird secured near Port Lincoln in 1919.

Haliaetus leucogaster (Gmel.) (White-breasted Sea-Eagle). One at least of these fine birds sailed round the summit of the northern part, occasionally descending to the haunts of the Pacific Gulls near the crossing, when the Gulls would vigorously chase it and drive it away. A mass of large sticks and *debris* near the summit on the southern part suggested an old nest.

Cerchneis cenchroides (Vig. and Horsf.) (Nankeen Kestrel). A pair of these Kestrels had their home at the summit of the southern part. Under a ledge of rock was an old large stick nest, doubtless belonging to them.

Owl. A large bird seen once at night and pellets found near the northern summit, suggest the presence of an Owl.

Neophema petrophila (Gould) (Rock-Parrot). Rock-Parrots constitute a considerable part of the land-bird fauna of the main island. Probably more than a hundred individuals are present. They are to be found where low shrubs and herbaceous plants occupy the soil between granite boulders and slopes, and particularly on the gentle limestone slopes, where a more abundant soil supports the loose shrub *Nitraria*, a crucifer (*Lepidium foliosum*, Desv.), and the rosemary-like composite *Olearia axillaris*, F. v. M. On the tops of these plants they settle before descending to search for seeds, or fly up to these points of vantage when alarmed. On other occasions they walk or fly on to exposed granite slopes and boulders, thus earning their name of Rock-Parrots. Occasionally they run over the flatter surfaces. The note uttered is a little twittering or almost whistling sound. I have not heard this same note uttered by the closely-allied *Neophema elegans*, a bird which was abundant in burnt scrub, in shrubby sandy land, and partly cleared grass land at Encounter Bay a fortnight later. In this connection it may be worthy of mention, as showing how an island habitat may be gradually acquired, that a flock of *Neophema elegans* (a bird was not secured for absolute identification) was met with in January, 1920, on Wright Island, a small island in Encounter Bay between Rosetta Head and Granite Island, about half a mile from the shore and a little over a mile and a half from where identified *N. elegans* were present on the mainland. These birds apparently passed from the mainland to the island and back again. On the island they were seen to be feeding on the minute seeds of the native tobacco (*Nicotiana suaveolens*, Lehm.).

Two specimens of *Neophema petrophila* were obtained, both males, but one in incomplete plumage. Male adult; iris, very dark brown; bill, very dark grey above, pallid horn below; pharynx, flesh coloured; legs, pale greyish-brown; claws, blackish. Total length, 22·6 cm. Span of outspread wings, 30·7 cm. Weight, 53 grms. T., 39·5° C. Ornithomyid fly amongst the feathers; mites on wings; numerous cestodes in intestines. Male not quite adult; soft parts coloured as in other bird. Total length, 21 cm. Span of outspread wings, 29·3 cm. Weight, 47 grms. T., 41° C. (Fluttered along after being shot.) Ornithomyid fly; mallophaga present; mites on wings; cestodes in intestines.

Chalcites basalis (Horsf.) (Narrow-billed Bronze Cuckoo). The presence of two at least of these birds was a surprise. To the significance of their occurrence reference has already been made. A male was secured; iris, reddish-brown; bill, black; inside of bill, black; pharynx, greyish flesh; legs, greyish-black. Total length, 16.5 cm. Span of outspread wings, 28 cm. Weight, 25 grms T., 41·1°. No ectozoa and no entozoa detected.

Hirundo neoxena, Gould (Welcome Swallow). A few Welcome Swallows were seen hawking round on the sandy beach on landing and on several occasions afterwards. They occasionally settled on the granite boulders. High up the side of the northern summit Swallows were seen entering and leaving shallow caves made by the weathering of the under parts of huge granite masses. Female bird; iris, dark brown; bill, black; pharynx and gape, yellowish; legs, black. Total length, 16.5 cm. Span of outspread wings, 30 cm. T., 37° C No ectozoa and no entozoa detected.

Petroica goodenovii (Vigors and Horsf.) (Red-cap Robin) In the tea-tree (*Melaleuca parviflora*, Lindl.) scrub and on open slopes covered with the composite *Olearia axillaris*, F. v. M., a number of these Robins were noticed In one place some eight or ten immature birds or females and one adult cock bird (moulting) were met with, the uncoloured birds flying from top to top of the low bushes or settling on the bare ground between. Adult male; iris, dark brown, nearly black; bill, black; pharynx and gape, orange; legs, black; soles, brownish-orange. Total length, 11 cm. Span of outspread wings, 18·5 cm. T., 40.2° C. Mites on wings; no mallophaga detected; no entozoa detected Immature; sex (?); iris, very dark brown; bill, brown; pharynx and gape, yellow; legs, blackish; soles, yellowish. T., 41° C. Mites on wings; mallophaga present; no entozoa detected.

Pachycephala pectoralis (Lath.) (Golden-breasted Whistler). Mr. Waite noted the presence of a *Pachycephala*, doubtless this species, in 1914. Several birds were on the island, being found in the tall tea-tree (*Melaleuca parviflora*, Lindl.) and sheoaks (*Casuarina stricta*, Ait.). A moulting adult male and an immature male were obtained. No tangible differences could be detected between these and mainland birds. Adult male; iris, reddish-brown; bill, black; pharynx, flesh coloured; legs, dark grey. T., 41·3° C. Ornithomyid fly amongst feathers; no mallophaga and no entozoa detected. Immature male; iris, reddish-brown; bill, black; pharynx, flesh coloured; legs, dark grey. Total length, 17 cm. Span of outspread wings, 26.7 cm. No ectozoa and no entozoa detected.

Ephthianura albifrons (Jard. and Selby) (White-fronted Chat). A number were present frequenting open slopes covered with *Mesembryanthemum* and other herbs and low bushes. Two birds were obtained, a male and a female. The colours of the soft parts were the same in each; iris, pale brownish-white with a tinge of pink; bill, black; pharynx, greyish flesh; legs, black. Total lengths: adult male, 13 cm.; female, 12.5 cm. Spans across outspread wings, 21.2 cm. and 20·8 cm., respectively. Weights, 15 and 13·7 grms. Ts., 38.6° C. and 39.2° C. Mites on the wings of both; no entozoa in either.

Artamus personatus, Gould (Masked Wood-Swallow) [?]. Two pale-bluish Wood-Swallows were seen, probably this species, hawking in the air or settling on dead or bare branches. They were exceedingly wary and would not allow of any near approach, and flew elsewhere after being disturbed.

Zosterops lateralis (Lath.) (Grey-backed White-eye). Silver-eyes were amongst the commonest land birds, frequenting especially the limestone slopes and places where shrubs grew amongst granite rocks. Here they might be heard and occasionally seen as they searched through the undergrowth, composed of the rosemary-like composite, the crucifer and *Myoporum insulare*, R. Br.,

more particularly, in search of food. A *Myoporum* seed was found in the intestine of one. In spite of the island being uninhabited, they were unduly wary; more so, in fact, than on the mainland. Three birds were shot, two females and a male; iris, brown in one female, light brown in the other two birds; bill, in all brown above, pallid below except the tip; pharynx, yellowish flesh; legs, pallid brownish-white to pale brown. Total lengths: female No. 2, 11·6 cm.; male, 12 cm. Spans of outspread wings: female No. 1, 16·3 cm.; female No. 2, 16·5 cm.; male, 18·2 cm. Weights: female No. 1, 10 grms.; female No. 2, 11 grms. Ts., 37·4° C., 40·3° C., and 39·1° C., respectively. No ectozoa and no entozoa detected in any.

Corvus coronoides, Vig. and Horsf. (Australian Crow). Controversy still rages as to whether in Australia we have two species of large Crows or only one species, but that a variable one. All ornithologists agree that the small white-eyed Crow, *Corvus bennetti*, North, is a definite species differing not only in size but in habits from the larger Crows. At a recent meeting of the South Australian Ornithologists' Association the pros. and cons. for a single species of large Crow were fully discussed, and the question was finally left undecided. The colour of the iris, it is clear, counts for nothing, immature birds having a brown iris and mature ones a white. The presence of hackles on the breast seemed also to be a matter of age. The colour of the bases of the feathers of the neck and back has been relied on as a guide. In some birds this is white, in others it is greyish, but the grey tint varies in degree. These grey-feathered birds are spoken of as Ravens, in contradistinction to the white-feathered Crows, so the depth of grey would necessitate considering some specimens as more "ravenish" than others. As the company of Crows on Pearson Island, probably some 30 or 40 in number, might be looked on as possibly having all had an origin from common parents, and consequently as all belonging to one species, several birds were shot in order to note any differences in individuals. All three birds turned out to be males, and all three had unduly large bills. One bird was a little smaller than its fellows and was obviously not mature. It differed from the others in having brown eyes instead of white ones, an absence of hackles on the breast, and an irregular pigmentation of the pharynx and tongue, instead of a uniform black tint. All three birds had grey bases to the feathers.

The following data were noted in connection with the three Crows shot:—Adult male No. 1: Iris, white; bill, legs, and pharynx, black; total length, 48·5 cm.; span of outspread wings, 96 cm.; mites on wings; mallophaga; nematodes in stomach and oesophagus. Adult male No. 2: Iris, white; bill, legs, tongue, and pharynx, black; total length, 56 cm.; span of outstretched wings, 104 cm.; mallophaga present; cestode; food present, the bones and fur of a rat. Immature male: Iris, dark brown; bill, black inside and out; tongue and pharynx whitish with irregular black patches; legs, black; total length, 54·5 cm.; span of outspread wings, 98·5 cm.; T., 41·6° C. (hot day). In the stomach, a number of leaves apparently of *Melaleuca* and Chenopodiaceous plants, but no animal matter. An occupied nest was seen on the north part of the island, and Professor Wood Jones found these birds nesting in *Casuarina* on November 25, 1920.

Sturnus vulgaris (English Starling). A small flock was seen flying on two occasions over the southern part of the island. This record cannot be considered as established beyond all doubt.

Passer domesticus (House Sparrow). This record is very doubtful. A fleeting glance of two or three birds that suggested sparrows and a note uttered which was also suggestive is all we have to go on. They were not seen again.

Parasites infesting the Species of Birds.

Cestodes were found in:—

Sterna bergi, Haematopus unicolor, Neophema petrophila, and *Corvus coronoides.*

Nematodes were found in:—

Corvus coronoides.

Mallophaga were present in:—

Sterna bergi, Haematopus unicolor, Neophema petrophila, Petroica goodenovii, and *Corvus coronoides.*

Mites were present on the wings in:—

Sterna bergi, Gabianus pacificus, Neophema petrophila, Petroica goodenovii, Ephthianura albifrons, and *Corvus coronoides.*

Ticks were present on:—

Eudyptula minor.

Ornithomyid flies were present on:—

Neophema petrophila and *Pachycephala pectoralis.*

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 10.—THE SNAKES OF FRANCIS ISLAND. TOGETHER WITH A NOTE ON THE NAME OF THE GEOGRAPHICAL GROUP.

By Edgar R. Waite, F.L.S., C.M.Z.S., Director S.A. Museum.
(Contribution from the South Australian Museum.)

[Read June 14, 1923.]

In recent publications, both of writings and maps, the group of islands referred to is entitled Nuyt's Archipelago, but the name of the illustrious Dutchman commemorated was not Nuyt, but Nuyts, or, in Dutch, Nuijts. It would seem, therefore, that the group of islands should be designated Nuyts Archipelago.

In a publication by Prof. J. E. Heeres[1] the following passages occur (p. 51):—

XVIII (1627).

DISCOVERY OF THE SOUTH-WEST COAST OF AUSTRALIA BY THE SHIP HET GULDEN ZEEPAARD, COMMANDED BY PIETER NUIJTS, MEMBER OF THE COUNCIL OF INDIA, AND BY THE SKIPPER FRANCOIS THIJSSEN OR THIJSZOON.

A.

Daily Register of what happened here at Batavia from the first of January, 1627.

. . . . On the 10th (of April) there arrived here from the Netherlands the ship **t'Gulden Seepaart** fitted out by the Zealand Chamber, having on board the Honble **Pieter Nuyts**, extraordinary Councillor of India, having sailed from there on the 22nd of May, 1626 . . . .

B.

Hessel Gerritsz-Huydecoper Chart (No. 5.—VII D).

This chart has **'t land van Pieter Nuijts** (discovered January 26, 1627) and the islands of **Sint Francois** and **Sint Pieter**.

The only snake that appears to have been definitely identified from the group of islands forming the Nuyts Archipelago is the common carpet snake (*Python (spilotes) variegata*, Gray), and an example of this species was obtained on St. Francis Island by Sir Joseph Verco, who at one period devoted considerable time to investigating the fauna of the waters of our various islands, in pursuance of his special study, the Mollusca.

Flinders met with a snake on St. Francis, recording its occurrence as "a yellow snake, which was the second killed on this island."[2]

Quite recently Mr. Francis Arnold, who resides on the island, told my colleague, Professor Wood Jones, that he knows of five kinds of snakes there, which he named as follows:—Carpet snake, black snake, brown snake, jumping

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(1) Heeres, "The part borne by the Dutch in the discovery of Australia, 1606-1765," Leiden and London, 1899.

(2) Matthew Flinders, Voy. Terra Austr., i., 1814, p. 109.

snake, and a small non-designated species, a specimen of which he sent to Adelaide.

The first-named may be the python; the jumping snake is a legless lizard (*Lialis burtonii*, Gray), a specimen of which was secured by Professor Wood Jones during his recent visit. It derives its local name from the peculiar and rapid action with which it escapes from a grass tussock during the periodic burning of the scrub.

What the black and brown snakes are we cannot yet say; they may be merely colour phases of a single species. The small unnamed snake presented to the Museum (numbered R. 1157) by Professor Wood Jones proves to be an example of

DENISONIA CORONOIDES, Günther.

Hoplocephalus coronoides, Günther, Cat. Colubrine Snakes, Brit. Mus., 1858, p. 215.
Denisonia coronoides, Boulenger, Cat. Snakes, Brit. Mus., iii., 1896, p. 336 (synonomy).

The island specimen of this common South Australian species is quite typical. It may be noted that the striations on the scales, said to be distinct, are so fine that they cannot be detected with the unaided eye.

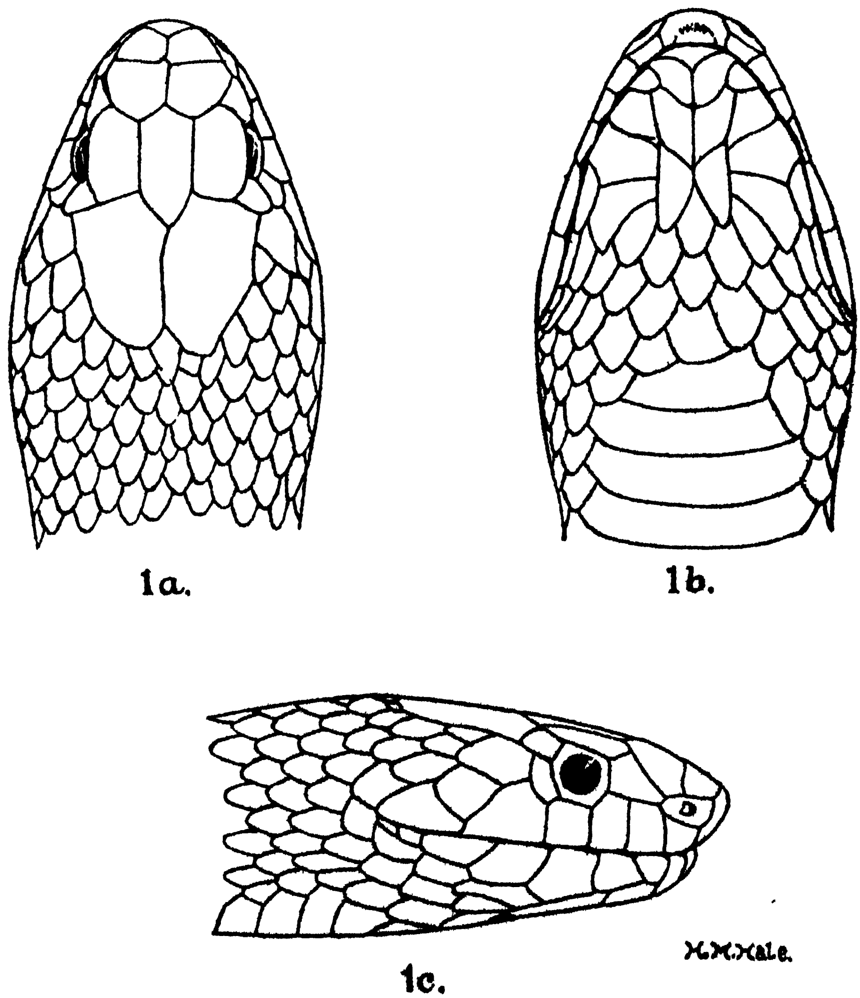

Fig. 1.
Head of *Denisonia coronoides*. 1*a*, Upper view; 1*b*, lower view; 1*c*, profile.

THE EXTERNAL CHARACTERS OF POUCH EMBRYOS OF MARSUPIALS. No. 5.—PHASCOLARCTUS CINEREUS.

By Frederic Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read May 10, 1923.]

Plate X.

Young stages of *Phasoclarctus* appear to be by no means common in collections. So far, I have had the opportunity of examining only one example, received in exchange by the kindness of Mr. Heber Longman, Director of the Queensland Museum.

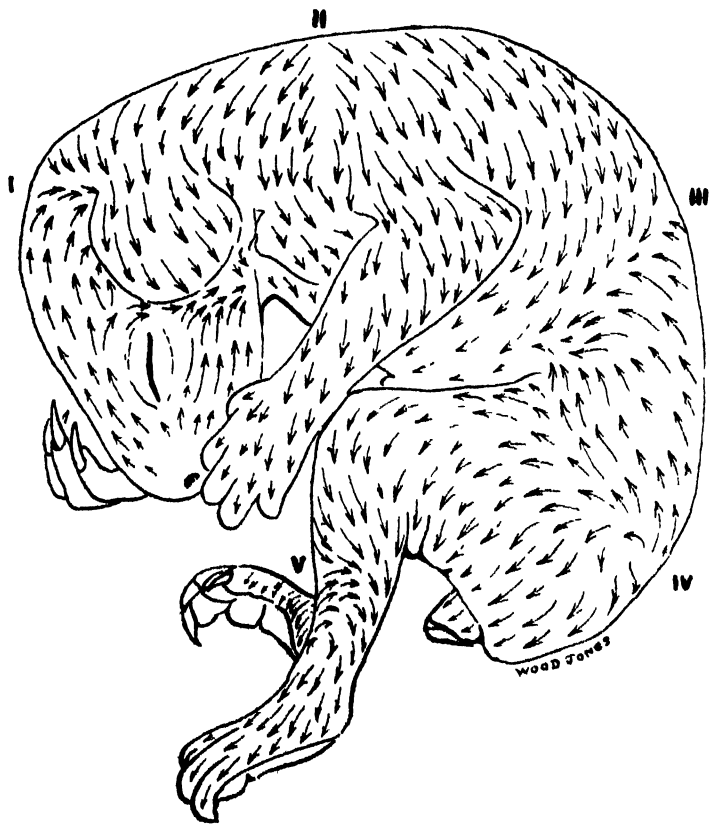

Fig. 1.
Phascolarctus cinereus.
Lateral view to show the general distribution of the hair tracts.

This specimen, which measures 110 mm. in R.V. length, is in the best possible stage for charting the hair tracts. Besides the peculiarities of the hair tracts, there are so many features of interest in the external characters that the

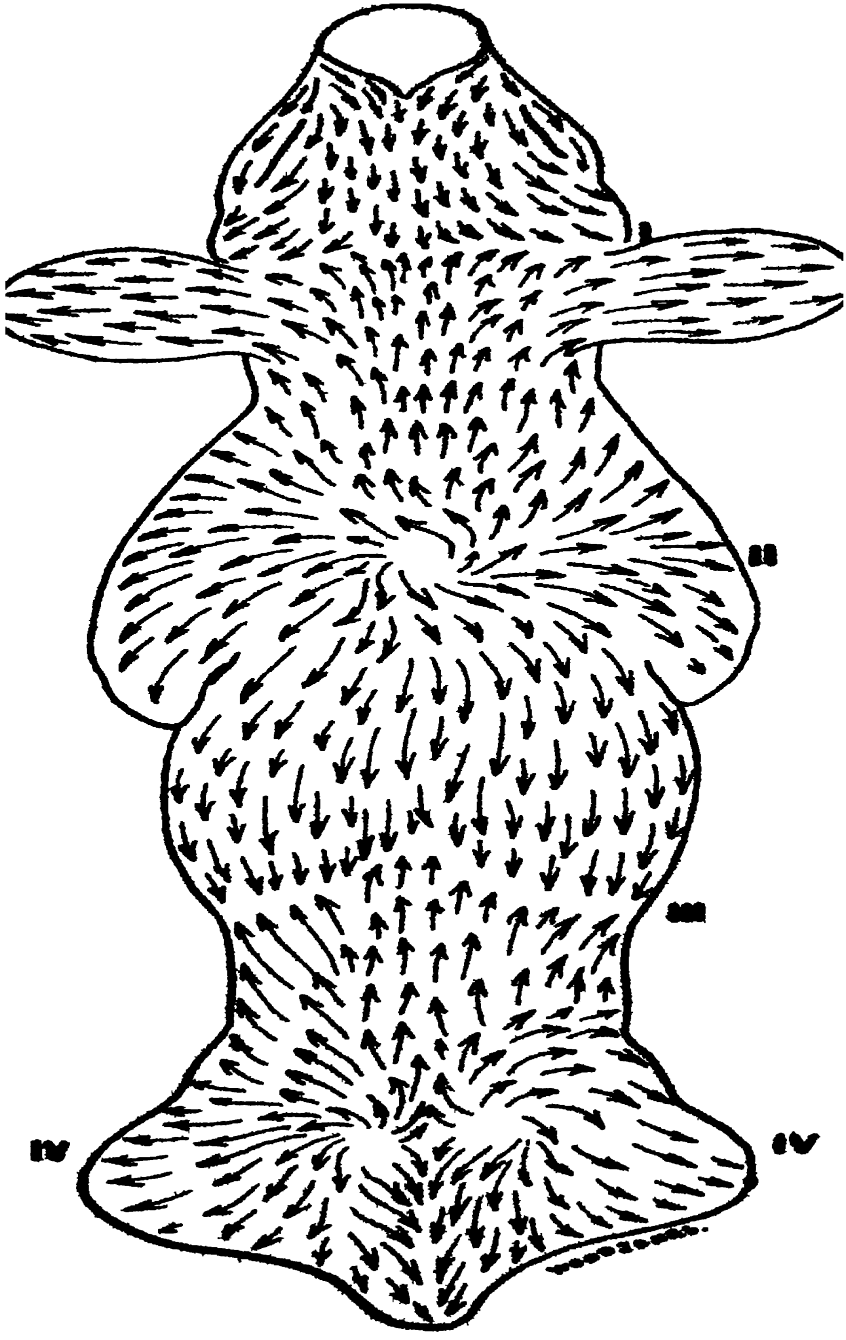

Fig 2

Phascolarctus cinereus.
General dorsal view of head and body to show the disposition of hair tracts.

specimen is worth describing for its own sake, although no comparison can be made with older or younger examples. The specimen is a male.

Hair Tracts.—In every way the Koala shows a remarkable complexity in the disposition of its hair tracts, a condition which is not readily appreciated

Fig. 3.
Phascolarctus cinereus.
The characters of the head and face.

by inspection of the woolly coat of the adult. The disposition of the tracts is shown in lateral and dorsal view in figs. 1 and 2.

Upon the head and face there is nothing very remarkable to note The dorsal extension of the rhinarium at this stage is pubescent with very minute

Fig. 4.
Phascolarctus cinereus.
Rhinarium viewed directly from the front.

down hairs, all of which are directed uniformly backwards. There is no reversal above the rhinarium; and upon the muzzle, face, and chin the hair is all directed caudad. The general backward slope is only interrupted at a line (indicated

by I. in the figures) which crosses the head at the anterior (superior) attachment of the auricle, and is continued down the side of the face and to the throat just in front of the ear. Caudad of this line the hair is directed forward, streaming directly cephalad on to the occiput, outwards on the dorsum of the auricle, and downwards and forwards on the neck. These cephalad pointing hairs are part of a whorled system (marked II.) which takes its rise upon the mid line of the back between the attachments of the two fore limbs. The vortex lies practically in the middle line, and the stream of hair points counter-clockwise. Hair from the vortex streams cephalad, as we have seen, and also downwards and forwards on the chest, downwards and caudad on the fore limbs, and directly caudad to the lower limit of the thorax. At the lower costal margin this caudally-directed stream meets a directly reversed stream at a well-marked line of convergence (marked III.), which passes from the dorsal region around the flanks and abdomen in front of the hind limb. The hair which streams cephalad to this line emanates from bilateral vortices (IV. and IV.[1]), situated close to the middle line over the sacral region. Of these two vortices the one on the left side is disposed counter-clockwise, and the one on the right side clockwise. This

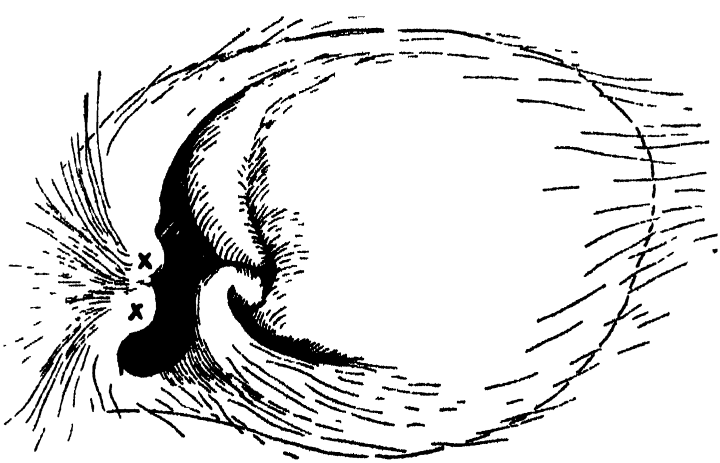

Fig. 5.

Phascolarctus cinereus.
Characters of the external ear.

disposition leads to the production of a mid dorsal convergent stream-line cephalad to the whorls (between them and the costal margin) in which the hair is directed cephalad and towards the mid line; and a mid dorsal convergent line caudad of the whorls in which the hair is directed caudad and towards the mid line. A little peak of hair marks the site of the absent tail. From the sacral vortices the hair streams downwards, with a general post-axial trend, upon the thigh and leg. Upon the front, and rather to the fibular side of the leg, and just above the ankle, is a further partially whorled area (marked V., in fig. 1). At this area of reversal, the hair streams upwards upon the fibular side of the leg, and, meeting the downward convergent stream from above, produces a well-marked convergent line, a divergent area being situated just above the flexure of the ankle. Upon the fore limb there are no reversals; but the post-axial convergent stream is particularly well marked.

Sensory Vibrissae and Papillae.—Over the whole body, the sensory vibrissae and papillae are peculiarly reduced. The facial vibrissae are represented by sparse and reduced members of only three of the typical five sets. The mystacial

group is reduced to about half a dozen short hairs, which have not the typical straight and elongated character of the bristles of this group, for they show a tendency to be curved, and to merge with the general hairy covering of the muzzle. Such as are well defined spring from the anterior portion of their usual area. A few somewhat inconspicuous bristle hairs represent the supraorbital

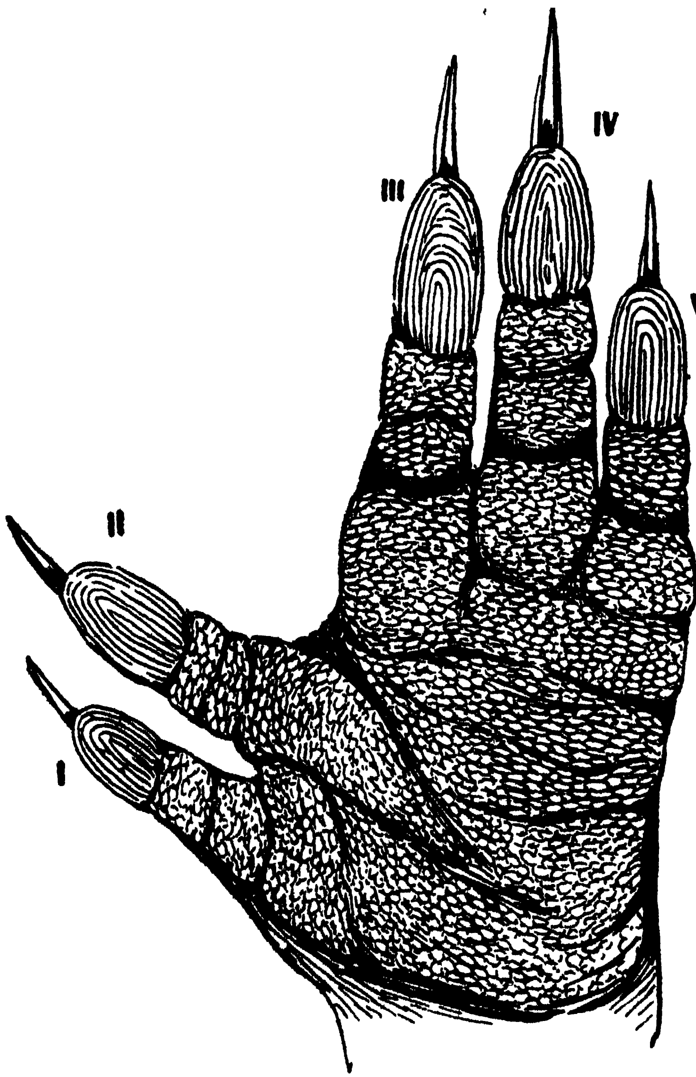

Fig. 6.

Phascolarctus cinereus.
Palmar surface of left manus.

set. I am unable to distinguish any members of the genal group, though Pocock figures two stout bristles in the adult (he, however, makes no reference to them in the text). The pale submentals are distinguished in but little, save their length and direction, from the general hair of the chin region, and the interramals are unrecognizable. I find no trace of ulnar carpal vibrissae, nor are any

sensory papillae or vibrissae to be distinguished upon any other part of the body in this specimen.

The Rhinarium.—In the adult the rhinarium is one of the most remarkable features of the animal, and all the adult peculiarities are well established in this specimen. It is curious both in form and extent. The causation and function

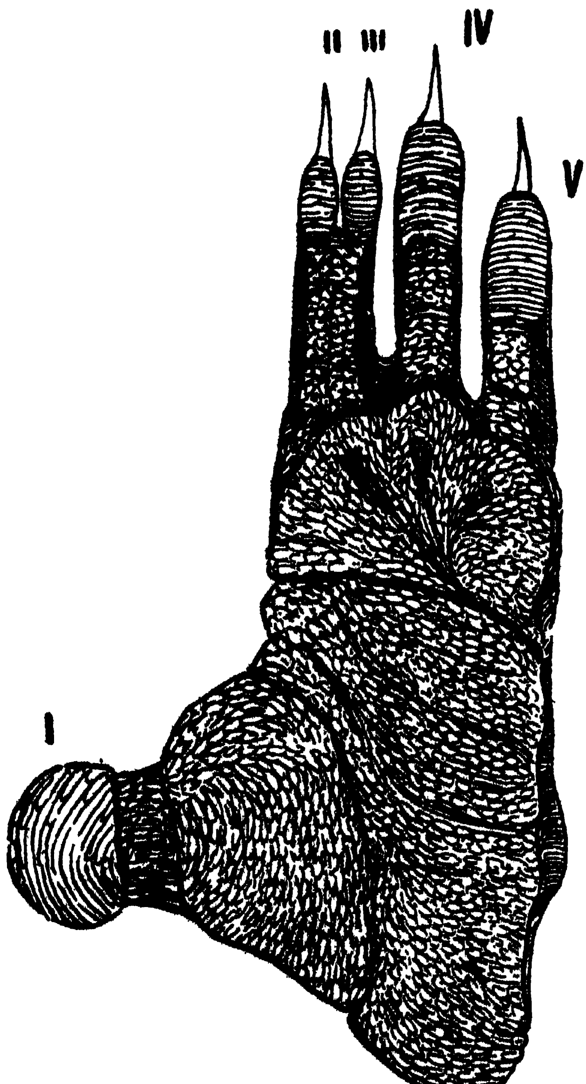

Fig. 7.
Phascolarctus cinereus.
Plantar aspect of left pes.

of this peculiar rhinarium, continued so far caudad in its dorsal part, await solution. The nares are slit-like, and owing to the extreme shortness of the mesial nasal process (columella and philtrum), they are practically confluent in their lower median extremities. Superficially the great lateral nasal processes

remain ununited, and it might be said that a most primitive type of anterior nares was grafted on to a most highly specialized type of rhinarium. The lower extremity of the mesial nasal process falls considerably short of the line of the upper lip, so that the animal may be said to have a well-marked median "hare-lip." The whole rhinarium is clothed at this stage by very minute down hairs, and its surface is finely punctate. In consequence of the presence of these fine down hairs, Pocock has been led into making the rather rash assertion that "there is no true rhinarium," a rather curious descriptive phrase for the animal which has the most conspicuous rhinarium of any marsupial. The dorsal shield-like expansion reaches caudad slightly past the anterior canthus of the eye.

The External Ear.—At this stage the external ear already shows the curious hair-covered flap-like appearance that is so characteristic of the adult. The concha is hairy both within and without, and a conspicuous tuft springs from the crus of the helix. There are here developed two genuine tragoid projections—genuine in the sense that they spring from the helix and not from the antihelix. These true tragoid projections are marked x in fig. 5. The antihelix is well developed, and at the middle of its length it is inflected and folded upon itself, so that it might be said that a superior and an inferior processus antihelicis were present, though neither upper nor lower portion can rightly be termed a processus. Of the adult condition of the auricle Thomas says, "The metatragus is almost obsolete," and by metatragus he doubtless refers to the superior part of the antihelix. In Pocock's description of the ear of the adult, and in the comparison of it with that of *Trichosurus vulpecula,* the homologies of the various anatomical parts of the concha are not appreciated in consequence of the limitation of the examination to adult material only. The inferior portion of the antihelix is bounded behind by a depression which constitutes a wide but shallow bursa or sulcus auris posterior. The auricle of *Phascolarctus* at this stage presents a strange and interesting admixture of characters which can only be interpreted by reference to forms not yet described in this series of papers.

Manus.—The digital formula is $4 > 3 > 5 > 2 > 1$. The manus presents the characteristic feature of the opposition of digits 1 and 2 to digits 3, 4, and 5; a condition which leads to a peculiar broadening of the palm in its proximal part. The first digit is not in any way specialized. The apical pads are well developed, and are striated; but the striations are not particularly deeply sculptured or conspicuous. The rest of the palm is granular, and although a linear arrangement of the granulations is apparent, no definite striations are formed in any part. The palmar pads are not well defined. The manus is relatively very large. All digits are armed with strong curved claws.

Pes.—The digital formula is $4 > 3\text{–}2 > 5 > 1$. The syndactylous digits are extremely well developed, being longer than the fifth digit and nearly as long as the fourth. Digit 1 is short and greatly broadened; it possesses no nail. Strong curved claws are present on all the other digits. The apical pads are well developed and striated. The whole of the sole is granular from the bases of the apical pads to the back of the heel. Plantar pads are not well developed.

External Genitalia.—The cloacal papilla is prominent and the genital tubercle is just exposed within its orifice in this example.

References:—(1) Oldfield Thomas, Cat. Brit. Mus., 1888, p. 209; (2) Pocock, R. I., Proc. Zool. Soc., 1921, pp. 591-607.

EXPLANATION OF PLATE X.

Phascolarctus cinereus.

Pouch embryo from Queensland Museum, 110 mm. in R.V. length. Slightly enlarged.

THE EXTERNAL CHARACTERS OF POUCH EMBRYOS OF MARSUPIALS.

No. 6.—DASYCERCUS CRISTICAUDA.

By Frederic Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read July 12, 1923.]

Of this somewhat rare and particularly interesting pouched-mouse I have been able to examine the external characters of fourteen young specimens. These embryos constitute two litters—the one a series of seven, which measure

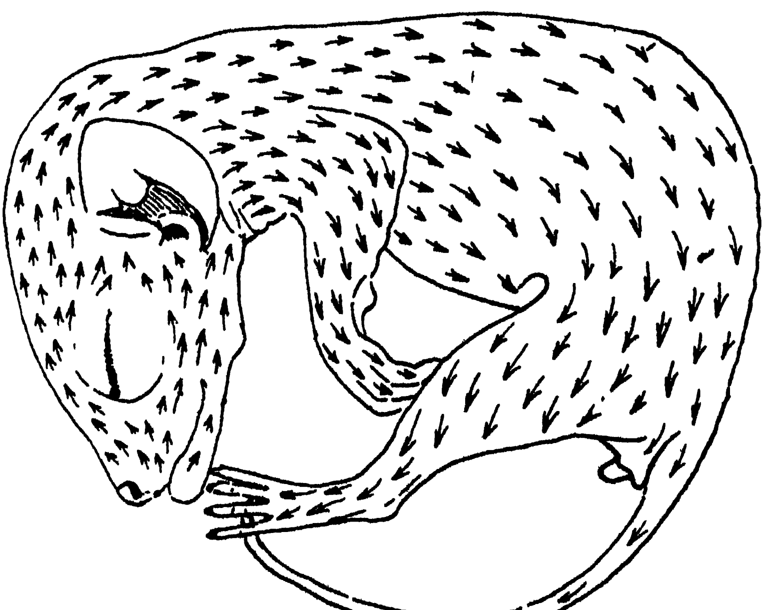

Fig. 1.
Dasycercus cristicauda.
Hair tracts of a male embryo, 25 mm. R.V. length.

15 mm. in R.V. measurement; and the other, also a brood of seven, which are 10 mm. longer in the same measurement. For all these young animals I am indebted to Mr. A. G. Bolam, of Ooldea, who forwarded the female animals, the one dead and preserved in spirit, and the other living.

The living animal was received on August 15, 1922, and she and her young were under close observation until September 17, on which day she unfortunately died. The very rudimentary condition of the marsupium, by which all the developing young are freely exposed for inspection upon the ventral surface of the mother, makes their study a particularly interesting one. The young animals were 25 mm. in R.V. length when the mother died. They freed themselves from the nipples after her death and were very vigorous, but they were impossible to rear by artificial methods.

It is a very remarkable thing to see the female animal stumbling about with the seven large young clinging to the nipples. They make a load which one would have thought her incapable of supporting, and yet the wonderfully active creature will chase insects and kill mice regardless of her burden. It might also seem that the naked and unprotected young would be perpetually liable to injury since their backs depend to the ground, and they are dragged about here and there as the mother's activities dictate. How long they remain adhering to the nipples is, so far, unknown; but it is hoped that the point may be cleared up, since this beautiful little animal is easy to keep in captivity. The young are robustly built, large-headed little creatures, with the face remarkably short and the upper jaw somewhat retracted.

Hair.—The hair upon the head is well developed and already pigmented when the embryo is no longer than 15 mm. in R.V. length. Hair is not discernable upon the rest of the body at this stage; and it is rather remarkable that no sensory papillae or vibrissae are recognizable at this stage. In the 25 mm. R.V. embryos the hair is beginning to appear all over the body, but it is still

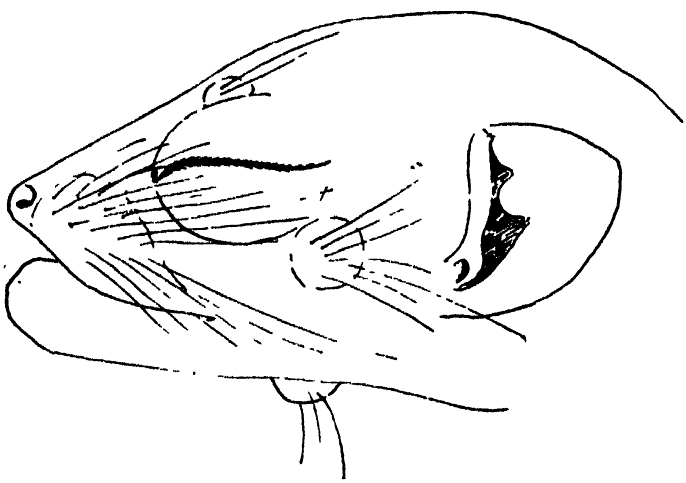

Fig. 2.
Dasycercus cristicauda.
Facial vibrissae of an embryo, 25 mm. R.V. length.

much more conspicuous and more deeply pigmented upon the head. All papillae and vibrissae are now well developed.

Hair tracts.—The arrangement of the hair upon the whole of the head, body, and limbs is of basal simplicity. The face, head, and the whole of the trunk and tail are clothed with hair having a uniform caudad trend. Upon the limbs the hair is uniformly in a distal and post-axial direction. There are no reversals, partings, convergences, or vortices anywhere. (See fig. 1.)

Vibrissae and papillae.—Although not distinguishable at the 15 mm. stage, all papillae and vibrissae are well developed in the 25 mm. embryos.

Facial vibrissae.—The vibrissae and papillae are well developed upon the face, but the submental group appears to be entirely lacking. In the adult there are some partially differentiated pale bristles in the submental region; but these are not recognizable at this stage. The supraorbital papilla is well marked, situated almost at the mid point of the upper eyelid, and giving rise to a couple of dark vibrissae. The mystacial set is clearly divided into an upper

and a lower group. The linear arrangement of this group is not easy to determine; but four rows would seem to be defined. The upper group, of which the individual hairs are dark in colour, is directed upwards and backwards; the lower group, of which the individual hairs are pale or white, is directed downwards and backwards. The same distribution and distinction in colour applies to the genal set, which consists of about half a dozen bristles arising from a

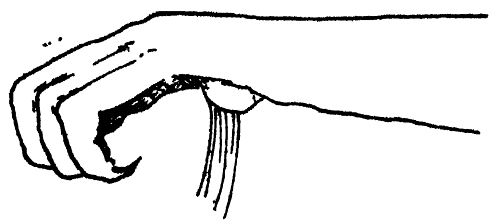

Fig. 3.
Dasycercus cristicauda.
The well-developed ulnar carpal papilla and its vibrissae.

particularly well-developed papilla. The interramal papilla is very conspicuous and gives origin to a group of three pale vibrissae. (See fig. 2.)

Brachial vibrissae.—Upon the limbs there is only one papilla developed, and this—the ulnar carpal—is particularly large. Some half a dozen well-differentiated bristles spring from it. (See fig. 3.)

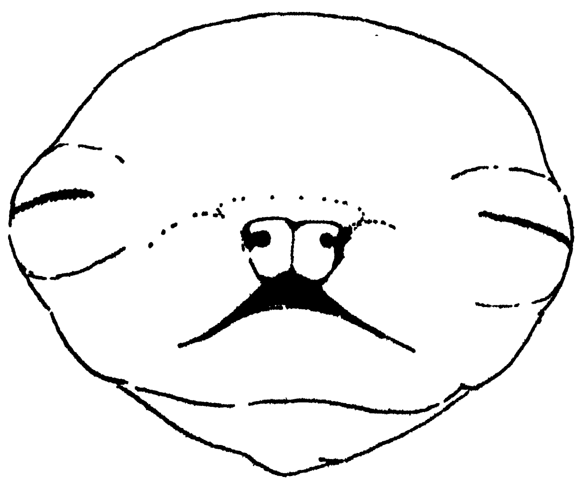

Fig. 4.
Dasycercus cristicauda.
Full face view of a small embryo, 25 mm. R.V. length, to show the condition of the rhinarium.

The rhinarium.—The short muzzle shows a rather distinct ridge which runs over the dorsum of the snout region behind the rhinarium, the ridge being expressed by a slight swelling which tends to be limited behind by a slight furrow. The ridge and the furrow are expressions of the abbreviation of the maxillary portion of the muzzle which is a conspicuous feature of the young animal. The naked rhinarium is somewhat square in outline, it is grooved in the middle line, and the anterior nares are cleft laterally. The rhinarium narrows but little as it passes to the upper lip, to which it makes a very considerable contribution,

there being, not a narrow labial prolongation, or a mere philtrum, but a broad area of the mesial nasal process in the middle third of the upper lip. (See fig. 4.)

The external ear.—In all stages examined the auricle is directed backwards. The actual development of the various auricular processes is exceedingly interesting. The mandibular portion of the auricle is at first prominent, and appears as a ridge, which is lobed and folded in its inferior extremity. In the lower portion of this ridge there seems to be at the 15 mm. stage the rudiments of a tragus and a tragus pocket; but with increasing growth the mandibular processes

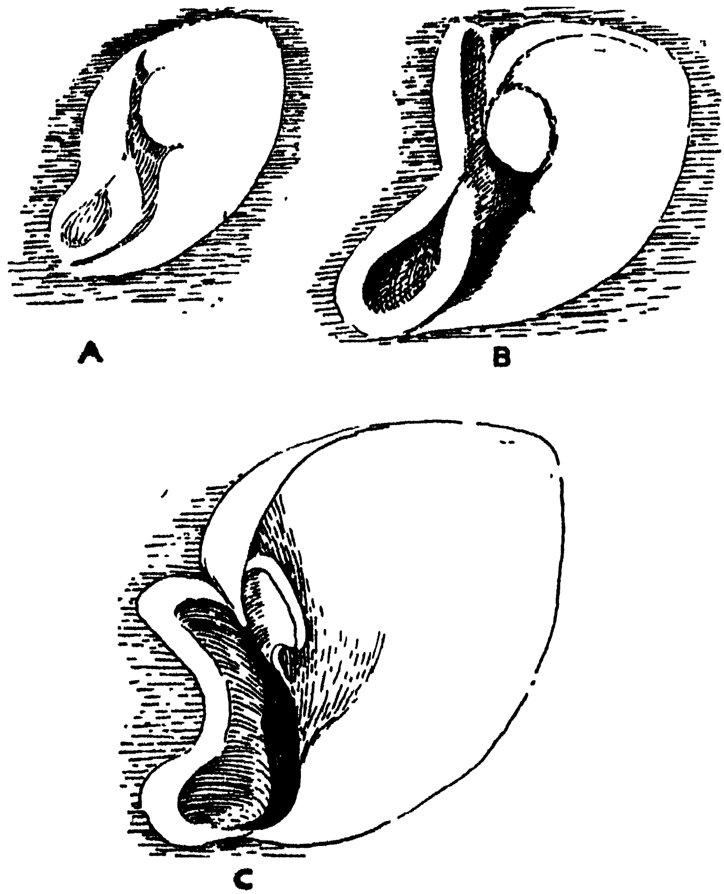

Fig. 5.

Dasycercus cristicauda.

Three stages in the development of the auricle.

A, a 15 mm. R.V. embryo.; B, a 25 mm. R.V. embryo; C, a young adult.

become flattened and riband-like, and finally appear as a tortuous sculpturing upon the pre-auricula region. The hyoid processes are at first three in number, of which the middle one is by far the most prominent. The middle process of the antihelix becomes progressively elevated and flattened from side to side, and ultimately appears as the almost leaf-like processes antihelicis of the adult. (See fig. 5.)

Manus.—The digital formula of the 25 mm. young is $3 > 4 > 2 > 5 > 1$; a formula which is also typical of the adult. The digits are fusiform, tapering towards the tips, and no apical pads are obvious. The whole of the palm is

granular. There are four typical interdigital pads. The thenar pad is present but small. The hypothenar pad is very well developed. A well-marked granule is differentiated in the centre of each pad.

Pes.—The digital formula is 3 > 4 > 5 > 2 > 1; or 3 = 4 > 5 > 2 > 1. In the adult the typical formula is 4 > 3 > 5 > 2 > 1. Apical pads are not obvious on the fusiform digits. Three typical interdigital pads are present at the bases of digits 2-3, 3-4, 4-5. In addition there is a small first interdigital pad at the base of the first digit. This pad is absent in the adult, at which stage the first digit is itself far more reduced than it is in the 25 mm young. It should be noted, however, that the degree of adult development of the first digit is extremely variable. The sole is entirely granular. A well-marked granule is present in the centre of each pad, but no sculpturing is as yet visible on the central granule.

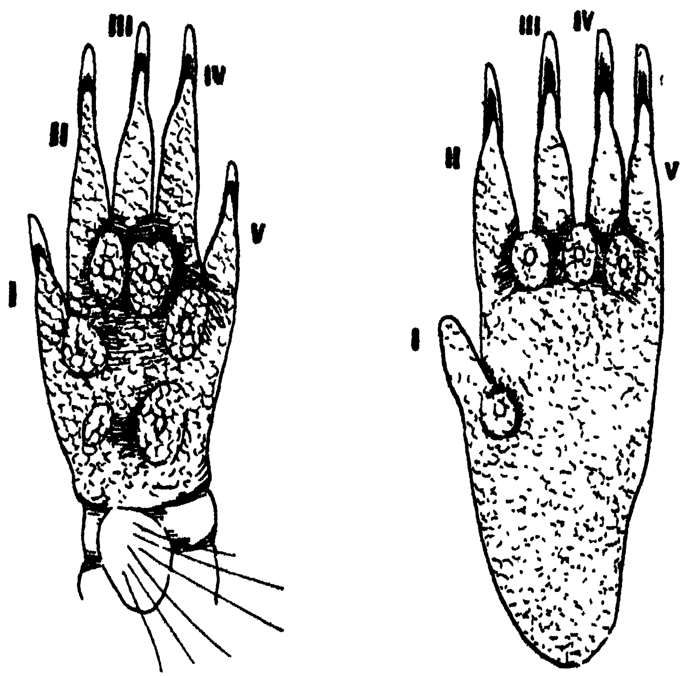

Fig. 6.
Dasycercus cristicauda.
Left manus and pes of a 25 mm. R.V. embryo.

External genitalia.—The male genital tubercle is exposed beyond the cloacal margin at the 25 mm. stage.

The mammary area of the female is of particular interest. Of the three females of the 25 mm. stage, one shows two bilateral mammary primordia, the second shows the two bilateral primordia and a single median more caudad primordium, and in the third (illustrated at fig. 7) there is a suggestion of a median division of the posterior median primordium. Very faint elevations run upon the lateral aspects of these mammary primordia and tend to delimit the mammary area from the general skin surface of the lower portion of the abdomen. Later stages should reveal changes of considerable interest. In the adult there are from 6 to 8 nipples arranged in crescentic lines. Considerable irregularity

seems to prevail in the actual arrangement of the nipples. In nursing females the distortion due to traction may possibly upset the normal order of disposition, but in two nursing females examined the condition appears to be a very irregular one. In the first female (shown at A, in fig. 8) four nipples are present in a crescentic line upon the right side of the marsupium area, whilst on the left side twin nipples represent the most cephalic member of the series, and a single nipple corresponds to the third member on the right side.

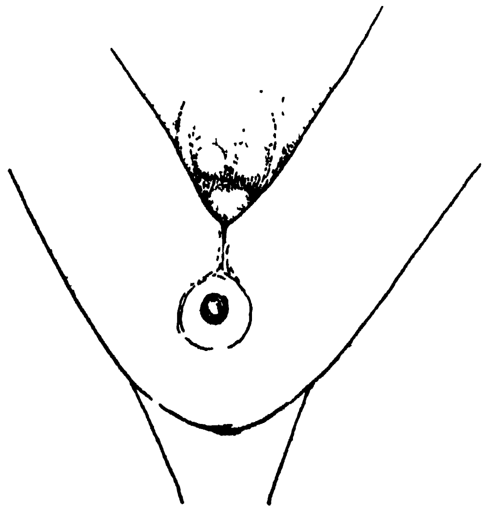

Fig. 7.
Dasycercus cristicauda.
Female at the 25 mm. stage to show the marsupium-area and mammary primordia.

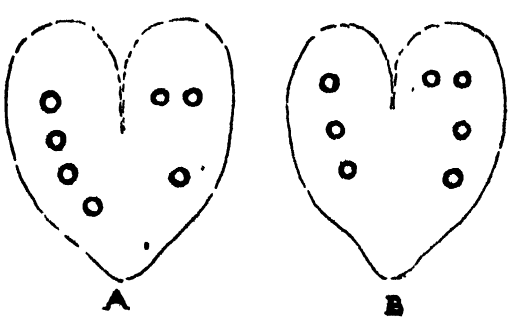

Fig. 8.
Dasycercus cristicauda.
Diagram to show the arrangement of the nipples in two nursing female specimens of *Dasycercus cristicauda.*

In the other female (B, in fig. 8) three nipples are on the right, and on the left twin nipples correspond to the first, and single nipples to the other two members of the right-sided series. It is hoped that during the coming season more material of this primitive and interesting didelphian may be obtained, and that further stages of mammary development may be studied.

THE STRUCTURE AND ACTION OF "STRIATED" MUSCLE FIBRE.

By O. W. Tiegs, D.Sc.,
Zoology Department, University of Adelaide.

[Read May 10, 1923.]

Plates XI. to XIV.

So numerous have been the investigations on the structure and action of striated muscle tissue, and so well do our general ideas on the subject appear to be established to-day, that a re-examination of the whole question may appear superfluous. Nevertheless, observations which I have been making recently have led me to conclude that many of our accepted ideas are quite erroneous, and I shall not hesitate to discuss the subject once more.

Historical Introduction.

Among those who have investigated the structure of striated muscle are to be mentioned Leeuwhenhoek, Bowman, Dobie, Kölliker, W. Krause, Hensen, Merkel, Engelmann, Schafer, Rutherford, Retzius, Rollett, Ramon y Cajal, McDougall.

Leeuwhenhoek is said to have regarded the striations as being in the form of a spiral thread wound around the outside of the cylindrical fibres. Bowman (1840) investigated the structure of the fibres carefully, and regarded the dark striations as closely packed discs stretching across the fibres; he recognized also the presence of muscle fibrillae. Nine years later Dobie observed a very faint line between the striations, to which Rutherford (1897) gave the name Dobie's Line. This "line" was shown by the investigations especially of Schafer (1873) to consist of a very delicate membrane which stretched right across the fibre (Krause's Membrane), on either side of which a layer of minute dim dots are to be seen; these dots, together with Krause's membrane, are to be looked upon as constituting Dobie's line. Rutherford, on the other hand, regarded Krause's membrane as being confined to the fibrils, and it was, according to him, not to be looked upon as a complete membrane stretching across the fibres. Schäfer's opinion has prevailed, and is, I am convinced, the correct one.

In 1868 Hensen described the pale stripe often seen passing through the striation (Hensen's Line). By some authors (*e.g.*, McDougall and Merkel) this line was regarded as a membrane stretching across the fibre like Krause's membrane. Rutherford, however, denies this view, and it is not accepted to-day.

Bowman, in his original account, had regarded the transverse discs as composed of minute particles closely arranged side by side so as to produce the disc, and less closely united behind one another to form the fibrils. To Kölliker (1851) we owe the modern conception that the fibrils are the primary components of the fibres, the arrangement of their individual striations to form the discs of the fibre being secondary. To a structureless substance lying between these fibrils, Rollet has given the name Sarcoplasma.

Meanwhile Schäfer (1891) working with the sarcostyles of the wing muscles of insects, structures which he regarded as highly differentiated fibrillae, has actually been able to observe internal differentiation of these delicate structures, minute tubules being observed in the region of the striation when examined with very high powers. As late as 1897, however, Rutherford wrote: "The finest structure of the fibrils is beyond the reach of the microscope, so that the secret of contraction will ever remain hidden."

Equally contradictory views have been held on the actual process of contraction. The observation of Schäfer that isolated sarcostyles of insect wing muscles can contract showed clearly that it is not in the sarcoplasm that we must look for the contractile mechanism, as Cajal believed. Bowman, in his original communication, had regarded contraction as taking place by the swelling of the striations. McDougall believed the swelling to be due to the passage, probably by osmosis, of water from the sarcoplasm into the fibrils. Schäfer has combated this view, and the inherent slowness of the process of diffusion under an osmotic pressure prevents its acceptance when we consider that during tetanus, mammalian muscles may contract at the rate of at least fifty times per second.

But even those who consider the contractile process to be confined to the fibrils differ in their interpretation of the action. According to Merkel, the dark portion of each sarcomere (sarcous element) diffuses during contraction through the sarcomere and accumulates around Krause's membrane, while the light portion in turn moves towards Hensen's line, so that there occurs a reversal of striation. Engelmann, on the other hand, concluded in 1873 that during contraction the dark part of each sarcomere, which was doubly refracting towards polarised light, remained, even in the fully contracted state, in the middle of the fibre, and that any reversal of striations in Merkel's sense was due to peculiar optical effects. This view, mainly through the work of Schafer, is maintained by most competent histologists to-day. Schäfer (1891) described a swelling of the sarcous elements in the highly differentiated wing muscles of insects, a process which he regarded as being due to the passage of the clear singly refracting material from the region of Krause's membrane into the sarcous element. By this means Krause's membrane became drawn up nearer to the sarcous elements; the latter bulged, due to the absorption of some of the singly refracting substance, and the slight increase in volume of the doubly refracting material that Engelmann had observed, was accounted for.

Rutherford (1897) took a view intermediate between that of Merkel on the one hand, and of Engelmann and Schäfer on the other. He conceived contraction as consisting of two processes: *(a)* A flow of clear (singly refracting) material into the sarcous element (similar to that of Schafer), and *(b)* a subsequent accumulation of dark material in the region of Krause's membrane (as observed by Merkel). Rutherford's view has not found acceptance by modern histologists.

Nevertheless, an examination of fixed contraction waves in muscle fibres shows most clearly that a reversal of striations, even if only apparent, has taken place. Nothing more convincing than the beautiful figure given by Schäfer of a contraction wave in a muscle fibre of *Dytiscus* could be desired. Schäfer accounts for the reversal in the following ingenious manner: "As the sarcous elements swell out more and more during contraction, the interfibrillar sarcoplasm becomes pressed from the spaces between the sarcous elements of adjacent fibrils, and accumulates in the region of Krause's membrane." It is this movement of the sarcoplasm which he regards as causing the reversal of striations.

The Structure, Action, and Development of Striated Muscle Fibres (excluding Wing-Muscles of Insects).

Methods employed.—For the examination of the minute structure of muscle fibre, I have throughout employed sections cut from paraffin blocks, and stained with iron haematoxylin. *Cold* Bouin's Piro-Formol mixture was used as a fixative (hot fixative must be avoided, as it causes rupture of the sarcous elements). Gold chloride preparations were also used, but, though these give sharply defined preparations of entire fibres, yet for the minute details of

intrafibrillar structure, they are much surpassed by the brilliant iron haematoxylin method of staining. For the examination of entire fibres ordinary glycerine or gold chloride mounts are sufficient.

Schäfer's observations on the minute structure of the fibrils were mainly made with the aid of the sarcostyles of insect wing muscles. A much more suitable material to employ, however, is the muscular tissue from fully-grown insect larvae. Growth of the larvae of metabolic insects takes place mainly as a result of a great hypertrophy of cells which are present already in newly-hatched larvae; there is no increase in their number, but they merely grow in size. There is usually not even an increase of their differentiation; everything, cellular and intracellular, is merely greatly hypertrophied, and such tissues obviously offer a great advantage for the study of structures which are just visible with the highest powers of the microscope. This will be clearly realized by comparing figs. 3 and 7 (pls. xi. and xii.); both are magnified 3,400 times. Fig. 3 is a fibril from a nearly full-grown beetle larva; fig. 7 represents some sarcostyles from the wing muscles of a wasp.

The results obtained with this excellent material I have throughout verified by the examination of skeletal muscle fibres from vertebrates, and the leg muscles of adult insects.

A remark may be made here regarding the interpretation to be placed on high-power examination of stained preparations. Many regard structures visible under such magnifications as artefacts due to the reagents employed. While this cannot be denied, it may be pointed out that if there is any distortion, some structures must have been previously present to be distorted; and while we cannot ascertain the actual living appearance of many of the minute structures thus rendered visible, still we can usually be certain of their definite existence. It should also be pointed out that results obtained by the high-power examinations of mitotic figures have been largely verified by the examination of living material.

In a recent paper (1922) I pointed out that the striations of voluntary muscle fibres did not run transversely across the fibres in the form of discs, as Bowman had originally supposed, but that they were disposed in the form of a double spiral which travelled from one end of the muscle fibre to the other. A double helicoid would have been a more accurate description. This structure is not, of course, to be looked upon as a *continuous* membrane in the form of a double helicoid, but is a structure composed of minute sarcous elements packed closely together, and so disposed within the fibre as to form the double helicoid. Usually this spiral arrangement of the striations is most difficult to detect, on account of the closeness with which it is wound. The observation becomes much easier if well-stretched fibres are examined, but even then considerable care is needed to observe it. It was the helicoid which Leeuwhenhoek saw and which he regarded as a thread running spirally around the fibre. It was also a partial view of this structure that Schäfer observed when he wrote: "When the muscular fibres are deeply focussed, the appearance of the striae becomes somewhat altered, and a fine line, often dotted, is seen passing across the middle of each light band." This is regarded as constituting Dobie's line, but is not identical with the structure spoken of by that name in the historical introduction above. The line is visible only in the middle of the fibre, and the smallest turn of the focussing screw downwards shows it to be continuous with another striation on the "lower" half of the fibre. It is, indeed, merely the indistinct view of the turn of the spiral on the opposite side, and not a distinct structure.

A careful examination of hypertrophied larval insect muscles amply justifies the view held by Schäfer that Krause's membrane is a complete membrane, passing

from fibril to fibril across the interfibrillar space and not confined to the fibrils, as Rutherford supposed. Its constant position between successive sarcous elements shows that it, also, must be arranged not as a series of successive discs, but as a double helicoid—*complete*, however, and not composed of minute elements (sarcous elements), as in the case of the "striations." The membranes of Krause, as Krause himself observed, are always inserted upon the sarcolemma (see figs. 1 and 2, pl. xi.).

The quantity of sarcoplasm between the fibrils varies considerably; in the muscles of very sluggish insect larvae it is present in only quite small quantities (fig. 1, pl. xi.). In the more active vertebrate muscles it is present in larger quantity, especially just beneath the sarcolemma. In the powerful wing-moving muscles of insects it is present sometimes in very large quantities; and in the most active of all these muscles, *viz.*, the wing-moving muscles of large wood moths or heavy beetles, it may be much more prominent than the fibrils themselves (see fig. 9, pl. xii.). In some insect wing muscles the sarcoplasm may, in fixed preparations, at any rate, show a curious architecture, strongly resembling the striations of other muscles; so prominent is this, that the true striations are not seen at first glance, and can only be observed by carefully examining the individual fibrils (fig. 9, pl. xii.).

When the individual sarcomeres are examined in the uncontracted condition each is seen to be a cylindrical structure (figs. 1 and 3, pl. xi.), often bulged in the middle (fig. 6, pl. xii.). At either end of this cylinder is the delicate Krause's membrane, and usually in close contact with this is to be found, even in insect wing muscle, a very minute amount of dark-staining material similar in appearance to the material constituting the striation, and corresponding to the dots figured by several authors in close connection with Krause's membrane. I shall speak of it as the *residual hyaloplasm*. In the greatly hypertrophied larval insect muscles a number of extremely delicate streaks of dark-staining material are just visible under the highest magnifications (fig. 3, pl. xi.), connecting this residual hyaloplasm to the striation, and staining similar to it. The interpretation of this is that there are in the clear part of the sarcomere minute channels (similar in appearance to those observed by Schäfer within the dark-staining sarcous elements of wing muscle) which connect the residual hyaloplasm, with the striation, or, as I shall call it, *movable hyaloplasm.*

Now if the individual sarcomeres are examined successively along a contraction wave, the actual contractile process within the sarcomere can be observed, and it can be most clearly seen that a process the very opposite to that maintained by modern histologists, actually takes place. As we pass down the contraction wave the striations become fainter and fainter and the dark material accumulates more and more around Krause's membrane (see fig. 15, pl. xiii.), *and the reversal of striations is actually seen to be produced within the sarcomeres, and not by the interfibrillar sarcoplasm*, as Schäfer maintains. In the greatly hypertrophied larval muscles the contracted state of the fibrils can be most clearly observed (fig. 2, pl. xi.), and the sarcoplasm is seen to have no relation whatever to the reversal that occurs; it is a phenomenon confined entirely to the fibrillae.

How may this process be reconciled with the observation of Engelmann that the relative positions of the singly and doubly refracting materials are unchanged? In the first place, the opinion has been advanced by Imbert (1897) that surface tension phenomena underlie muscular contraction; Bernstein (1901) showed, however, that the decrease of area of the movable fluid, as required on Imbert's view, is insufficient to account for the work performed during contraction, unless a further differentiation, which might be in the form of a spongy network, occurs within the sarcous elements. Schäfer has described

bundles of minute tubules lying within the sarcous elements, and these, taking up fluid from the clear part of the sarcous element during contraction, shorten and bulge. This observation might be taken as a confirmation of Bernstein's view; nevertheless, as I shall show later, in connection with the structure and action of wing muscle, it is founded on an incorrect observation, and is in part, at any rate, to be quite differently interpreted. The necessity for the existence of a spongy network, however, remains, and it seems to me that no better confirmation of the presence of such a structure could be desired, than the observation that the middle of the sarcomere remains doubly refracting towards polarised light even after the darkly-staining fluid has retreated, during contraction, from that region. It is, in fact, the spongy network which is doubly refracting. Into it, in the expanded state of the muscle, the greater part of the darkly-staining material is drawn through the minute channels which I have described above as occurring in the clear region of the sarcomere, leaving only a small quantity of residual hyaloplasm behind, in the neighbourhood of Krause's membrane. At contraction, the excitatory stimulus must decrease the surface tension of the hyaloplasm, and the portion that has been drawn through the tubules into the doubly refracting region, and which now forms the striation (movable hyaloplasm), is rapidly sucked back and accumulates at either end of the sarcomere, in the region of Krause's membrane. That contraction is the result of a *decrease,* not increase of surface tension was first pointed out in a paper by Dr. T. Brailsford Robertson (1909).

At relaxation, on the other hand, there is an increase of tension; the hyaloplasm from either end of the sarcomere is sucked rapidly up the tubules again and enters the doubly refracting spongy network. In many muscles the fusion of the hyaloplasm from either end of the sarcomere is not complete, and we obtain a pale line in the middle of the striation, which is Hensen's line (fig. 5, pl. xi.). It is especially clearly seen in the sarcostyles of the wing muscles of insects.

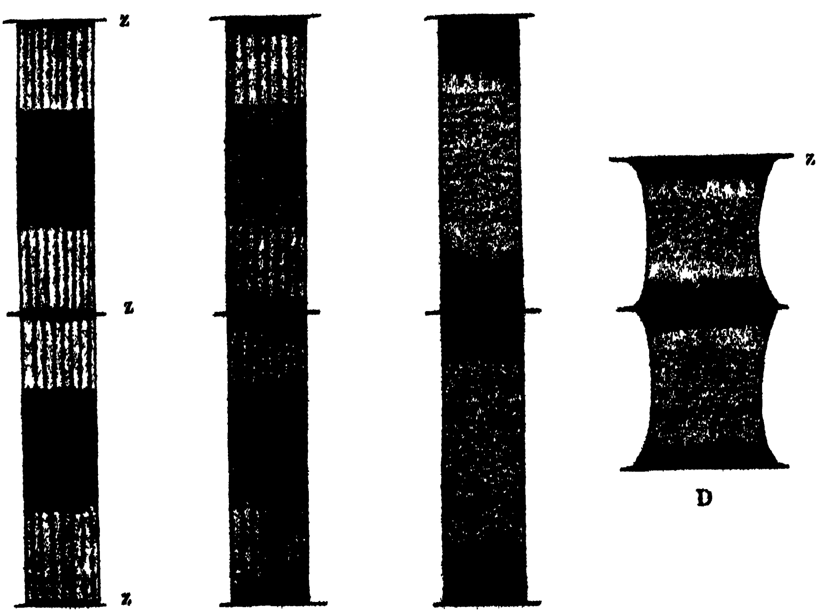

Diagram of two sarcomeres undergoing contraction. The dark substance is the hyaloplasm (movable and residual). The dotted part is the doubly refracting "spongy network." Z is Krause's membrane.

The accompanying diagram, which illustrates the process of contraction of a sarcomere, shows another feature of the contractile process to which I hope to refer more fully in a later paper. When individual sarcomeres are examined during their gradual passage into a contracted region of the fibre, it is seen that, although the dark-staining material is rapidly accumulating at the Krause's membranes, yet no appreciable shortening of the sarcomere takes place. It is only when the whole of the movable hyaloplasm has accumulated in the region of Krause's membrane, that the former spreads out sideways, greatly increasing the diameter of the sarcomere, and automatically shortening it. Not till now, indeed, do the sarcomeres appreciably shorten; they forsake their cylindrical shape, and become converted into short dice-box shaped structures (fig. 2, pl. xi.). We recognize, in fact, a short, but yet appreciable, latent period of contraction. The curious shape of contracted sarcomeres likewise accounts for the increase in volume of doubly refracting material as observed by Engelmann. A glance at fig. 2, pl. xi., will show that a considerable part of what would appear doubly refracting in all but very thin sections, is in reality not occupied by doubly refracting material at all, but is made up of the interfibrillar spaces.

The development of muscle fibres is best examined in insects. The process has been studied by a number of authors, and I shall refer to it only briefly here, in order to show the fundamental difference in the nature of ordinary striated muscle and wing muscle of insects.

The following brief remarks refer to the development of the leg muscles of insects, as I have observed it in a small chalcid wasp *(Nasonia)*. The muscle is developed from embryonic cells (myoblasts) which in the early pupa form thick columns of cells in the several segments of the leg (fig. 12, pl. xii.). These columns later break up into a large number of secondary columns, formed each of a single row of cells, arranged one behind the other. Adjacent cell-walls break down, and each column is now represented by a long syncytial column, with numerous nuclei arranged in a chain along its central axis (fig. 13, pl. xii.). An internal differentiation of each of these columns later occurs, and the whole mass breaks up into minute longitudinal fibrillae (fig. 14, pl. xii.). These fibrillae then differentiate into alternate dark and light parts, and the disposition of them is such that they collectively form a double spiral within the fibre. The wing muscles of insects, as I will show later, have a wholly different mode of origin.

Note on the Motor Nerve Endings on Striated Muscle Fibres.

In the endings of different nerves on striated muscle fibres of the frog I have observed a curious feature to which attention has not, so far as I am aware, hitherto been drawn. If a partial side view of the end plate nuclei is obtained there can generally be seen protruding from the lower part of each nucleus a minute process. I cannot say whether it is the termination of one of the minute fibrils of the nerve ending, which sometimes appear to enter the nuclei, or whether it is a process formed directly from the nucleus. But of its existence there can be no doubt, and such a process is always found to lie in close connection, not with the muscle "striation," but with Krause's membrane (fig. 20, pl. xiv.) Even ordinary muscle nuclei can, in side view, be clearly seen to have a direct connection with Krause's membrane. This is clearly shown in fig. 21, pl. xiv., taken from the leg muscles of a Myriapod *Scutigera*. The nuclei, here, occur along the central axis of the fibre; and each nucleus is seen to be connected by short processes with Krause's membrane. The example is taken, it should be noticed, from a contracted region of the fibre; there has occurred an

accumulation of dark material around Krause's membrane, which is thus hidden from view.

The Structure, Development, and Action of Wing-moving Muscles of Insects.

In general appearance the structure of these remarkable tissues is similar to that of other striated muscle fibres. There is usually, except in weak flyers, a great preponderance of sarcoplasm; the sarcostyles can be separated very easily from one another, as Schäfer observed, but in other respects they appear fairly identical with other striated fibres. Double spiral striations, Krause's membranes, and a sarcolemma are all present; nuclei occur in very large numbers on the *outside* of the muscles, but the muscles show no tendency to split transversely, as do other striated fibres. Nevertheless, in spite of the wonderful similarity between these two types, they develop in entirely different ways, and are to be regarded as having evolved, therefore, from entirely different sources. Their similarity, indeed, is to be looked upon as the result of a wonderful process of convergent evolution, rivalling anything that one finds among the organs of vision of the various groups of animals.

The following account is the result of an investigation of the development of the wing-moving muscles of a chalcid wasp *(Nasonia)*. In the metamorphosing larva there is formed on either side of the thorax a longitudinal column of embryonic myoblasts, which develop at the expense of certain of the larval thoracic muscles. In the larva shortly before its pupation these myoblasts have consolidated to form each a narrow band inserted behind and in front upon the thoracic walls, and the larval muscles have been entirely absorbed (fig. 16, pl. xiii.). Several hours later certain of these myoblasts cohere to form five long syncytial columns, passing within the band from one end to the other (fig. 17, pl. xiii.). Later these syncytia grow in thickness by the incorporation of more cells (fig. 18, pl. xiii.). Shortly after pupation a remarkable thing is to be observed. The myoblasts surrounding each syncytial column develop a process at either end, and these processes grow into the columns, and develop eventually into the sarcostyles of the adult insect, each becoming inserted on to the thoracic wall by its terminations. Fig. 19, pl. xiii., which is a longitudinal section along the edge of a syncytial column, shows this process going on.

As development continues, more and more of the myoblasts develop into bipolar cells, and send their processes into the sarcoplasm, and when in the adult insect the number of sarcostyles comprising a fibre is estimated, these are found to be approxmately equal in number to the nuclei which surround the fibre (between 800 and 900). Eventually the five complex columns so formed become drawn apart by the pull exerted upon them by the thoracic walls, and the five longitudinal wing-moving muscles are to be recognized, on either side of the body. (Each of the five pairs of muscles in this insect is a single multicellular fibre; in some insects more than one such fibre may be present.)

By this extraordinary process, then, there is developed a true muscle fibre: the outer walls of the cells represent the sarcolemma, the sarcostyles represent the fibrillae, and the protoplasm of the syncytial columns becomes the sarcoplasm. Eventually the sarcostyles develop alternate dark and light discs, adjacent ones being so disposed as to form a double spiral (helicoid) within the fibre, and the formation of minute Krause's membranes, produced apparently from the sarcostyles, completes the extraordinary development.

Perez (1910) has examined the development of the wing muscles of the blow fly. He comes to entirely different conclusions from those stated above, but his figures show clearly that the process is no different in that insect from

what I have found in *Nasonia;* what he took for five degenerating larval muscles are in reality the five syncytial columns to which I have referred above.

But in spite of the close convergence, small differences do occur between these wing muscles and other striated fibres—Hensen's line is much more prominent than in skeletal muscle (compare figs. 5 and 7, pls. xi. and xii.); the muscles also contract much less in extent than others. It should be observed that, in spite of the name given them, they are not usually inserted on the wings directly; their function is simply to alter the shape of the thorax, movement of the wings taking place by a "ratchet and pinion" mechanism between the wings and the thorax. While many skeletal muscles can contract to nearly one-quarter their length, contracted wing muscle fibres are not very much shorter than when extended; if this were otherwise they would immediately rupture the whole thorax. It should also be observed that the rate of contraction of these structures is probably considerably less than the rate of vibration of the wings; a single contraction of a fibre may conceivably bring about quite a number of vibrations.

It was mainly in the sarcostyles of the wing muscles that Schäfer (1891) studied the process of contraction, and by comparing the appearance of relaxed sarcostyles with what he regarded as contracted ones, he came to the conclusion that contraction consisted in an absorption, by the sarcous element, of part of the fluid from the clear region of the sarcomere. There is, however, it seems to me, a fatal objection to be raised against Schäfer's conclusion. His evidence for a contracted state of the sarcostyle lies evidently in a comparison of the thickness of these structures; thus, the sarcostyle shown in fig. 3 of Schäfer's paper is evidently regarded as a contracted state of that shown in fig. 2, because of its much greater thickness. I am convinced, however, that, even though the statement may seem absurd, both sarcostyles shown in figs. 2 and 3 of his paper are to be regarded as equally relaxed. I find that a single sarcostyle may vary greatly in thickness in various regions along its length, being narrowest at the middle of the muscle, and gradually broadening out towards its termination, where it becomes inserted upon the thoracic walls. Thus, figs. 2 and 3 of Schäfer's paper may be compared with figs. 7A and 7C (pl. xii.) of the present paper, which show that the sarcostyles may be actually three times as thick at their insertions as in other regions. The criterion of a contracted state should not be the thickness of the sarcostyles, but the distance between successive Krause's membranes. Krause's membrane is only to be recognized when we can observe it stretching from one sarcostyle to another across the interfibrillar space, and no such structures are shown in Schäfer's figures. Any dark lines that one sees *within* the sarcostyles between the dark discs are to be regarded probably as false optical effects, and an examination of Schäfer's fig. 3A shows that this line is not present in the five clear spaces in the middle of the sarcostyle. Krause's membrane, in fact, is a most difficult structure to recognize. It should be noticed, that if the distance between *two* clear areas in fig. 3A is measured (which, according to my view, is the distance between the successive Krause's membranes, even if these are not visible), then we find that this distance is approximately equal to that between the successive Krause's membranes shown in fig. 2A. (The dark line within the clear area of this figure could scarcely be an optical illusion, because the sarcostyle is so much thinner, and the distance betweeen the dark discs ever so much greater.) It should also be noted, in support of what I have said above, *that no Hensen's line is visible* in Schäfer's fig. 3A, if his interpretation be correct. In reality, however, Hensen's line is quite as prominent in this figure as elsewhere, but it is to be looked for, not within each of the dark areas, but between every second pair. The force of this is more clearly seen when we examine the well-known figure to be found in most histology books of the three sarcostyles from the wing muscles of a wasp (see

Schäfer's Essentials of Histology, 1920, fig. 174A). These figures are to be regarded as slightly diagrammatic, and represent Schäfer's interpretation of actual photographs. In the thickest of these, which is regarded as a contracted condition of the other two, a faint Hensen's line has been indicated; yet no such structure is visible in this portion in the original microphotographs (fig. 3A of the 1891 paper).

From the above account it will appear that Schäfer's conclusions rest on no very secure basis; there is no evidence to show that what he regarded as contracted sarcostyles were really such. When on the contrary, contracted sarcostyles *are* observed, we find that a movement of the dark material has taken place, just as occurs in other striated fibres (fig. 8, pl. xii.). There is also some evidence to show that the degree of contraction of individual sarcomeres is less in wing muscles than in other fibres. The length of a contractile wave in wing muscle is not known; but unless it is very minute indeed, a contraction of the individual sarcomeres to less than half their length, such as would be the case if Schäfer's interpretation of fig. 3A be correct, would immediately result in a collapse of the thorax of the insect. While the rate of contraction of wing muscle tissue may be more rapid than that of other striated fibres, there is no evidence to show that the degree of the contraction is so extensive as in other striated fibres.

I wish, in conclusion, to thank Mr. W. Fuller for the loan of some excellent gold chloride preparations. From one of these, fig. 20, pl. xiv., has been drawn.

Summary.

(1) The striations and Krause's membranes of muscle fibres are disposed not as transverse discs, but in the form of a double spiral (helicoid) which stretches from one end of the fibre to the other.

(2) In wing-moving muscles of insects the sarcostyles are developed each from one cell; in all other fibres they are of intracellular formation. The similarity between ordinary muscle fibres and wing muscles is the result of a remarkable process of evolutionary convergence.

(3) A sarcomere is constituted as follows:—In connection with Krause's membrane is a minute quantity of *residual hyaloplasm* which communicates through minute tubules in the clear region with the material of the striation *(movable hyaloplasm)*. At contraction the surface tension of the hyaloplasm evidently decreases, and the movable hyaloplasm is rapidly drawn down the tubules, having retreated from the doubly refracting spongy network which mechanical conditions show must be present within the sarcomere. There is then a true reversal of striations. At relaxation there is an increase of surface tension, and the hyaloplasm is again drawn up the minute capillary tubes.

(4) Schäfer's and Engelmann's interpretation of muscle action can no longer be accepted.

(5) Ordinary muscle nuclei, as well as motor end plate nuclei, have an intimate relation with Krause's membrane.

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EXPLANATION OF PLATES.

Lettering:—M.H., Movable Hyaloplasm; R.H, Residual Hyaloplasm; S., Sarcoplasm; Z., Krause's Membrane.

Plate XI.

Fig. 1. Portion of uncontracted body muscle of full-grown larva of a beetle *(Cnemoplites blackburni)* in thin longitudinal section (x 2000). The individual sarcomeres are clearly seen; Krause's membrane is also prominent, and its insertion on the sarcolemma is shown. A small quantity of sarcoplasm is visible.

Fig. 2. The same, in a contracted state (x 2000). The "reversal" of striations, *i.e.*, the accumulation of the movable hyaloplasm around Krause's membrane is clearly seen, and is recognizable as occurring *within* the fibrillae, and not outside them.

Fig. 3. Portion of a fibrilla from same (x 3400). Krause's membrane is seen projecting beyond the fibril. Around it is a minute amount of residual hyaloplasm, connected by very minute streaks of hyaloplasm with the central striation (movable hyaloplasm).

Fig. 4. The same (x 3400) in a contracted state. The narrowing of the fibril towards the lower end is due to its being cut slightly tangentially.

Fig. 5. Part of leg muscle of an adult chalcid wasp *(Nasonia)*. Note Hensen's line; also the residual hyaloplasm (x 2000).

Plate XII.

Fig. 6. Part of body muscle of *mature larva* of same *(Nasonia)*. The drawing is from a thin longitudinal section, taken near the insertion of the muscles upon the integument, which at this stage has chitinised (x 2000). The residual hyaloplasm is very clearly seen.

Fig. 7. Parts of uncontracted sarcostyles of flying muscles from a small chalcid wasp *(Nasonia)* (x 3400).

A. From the middle of the muscle.

B. The same fibril, rather nearer its point of insertion on the integument.

C. The same, close to its insertion on the integument.

Fig. 8. Part of two adjacent sarcostyles from flying muscles of a Cetoneiid beetle, in the contracted state. Note the accumulation of hyaloplasm around Krause's membrane A small amount of sarcoplasm is seen (x 3400).

Fig. 9. A number of uncontracted sarcostyles from flying muscle of a large wood moth (x 1700). Note the great spaces between the sarcostyles; also Krause's membrane connecting adjacent sarcostyles. Note also the remarkable architecture of the sarcoplasm.

Fig. 10 Contracted fibrils from gastrocnemius of mouse (x 3000).

Fig. 11. The same, uncontracted (x 3000). Note the "splitting" of the striations (Hensen's line).

Fig. 12. Developing leg muscle of a chalcid wasp *(Nasonia)*. One myoblast is seen in mitosis (x about 1500).

Fig. 13. A small part of one of the columns of myoblasts which results secondarily from a splitting of the mass seen in fig. 12.

Fig. 14. The same undergoing fibrillation. Striations not yet visible (x 2000).

PLATE XIII.

Fig. 15. Fibrillae from leg muscle of a myriapod *(Scutigera)* in various stages of contraction. The reversal of the striations is obvious (x 3400).

Fig. 16. Transverse section of one of the pair of bands of thoracic myoblasts, which will produce the five wing-moving muscles of the imago. Taken from a metamorphosing larva of *Nasonia* (x about 1100).

Fig. 17. The same, several hours later. Five syncytial columns have been formed.

Fig. 18. The same, at a slightly later state of development. Note the increase in size of the five columns. Some myoblasts are seen in mitosis (x 1200).

Fig. 19. Longitudinal section of one of the syncytial columns at a later stage of development (x 1200). The section cuts along the line of junction of the syncytial column and the surrounding myoblasts, and the latter are seen giving off long processes (sarcostyles) into the syncytial mass (sarcoplasm). Many myoblasts have been omitted from the drawing so as to give greater clearness.

PLATE XIV.

Fig. 20. A motor nerve-ending, from muscle of frog. Notice the relation of the end-plate nuclei to the Krause's membranes. Striations have not been drawn (x about 2000).

Fig. 21. Longitudinal section along middle of leg muscle fibre of *Scutigera*, to show relation of nuclei to Krause's membrane. The fibre is contracted, so that Krause's membrane is hidden by the dark material (striation).

ON THE PATH AND VELOCITY OF THE EXCITATORY IMPULSE WITHIN STRIATED MUSCLE FIBRES.

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[Read May 10, 1923.]

In previous papers (1922, 1923) I have pointed out that the "striations" of voluntary and cardiac muscle fibres are always arranged in the form of double spirals (double helicoids) which travel from one end of the fibre to the other. I have also found that in insect wing muscle, which has a wholly different type of embryonic development, the complex multicellular fibres have adopted this same arrangement of "striations."

The fact that two such tissues as ordinary skeletal muscle and insect wing muscle, which have evolved from wholly different sources, should have found it necessary to adopt this same arrangement of their "striations," seems to show that the spirals are of some fundamental importance for the successful functioning of these tissues; and it would seem that the slightly more even distribution of the strain within the fibres, which would result from this, is not sufficient to account for its occurrence.

The function of the spirals is to be looked for in a wholly different direction, and there is considerable evidence to show that it is along the spirals that the excitatory impulse travels within the fibre. The evidence for this statement is twofold:—

(1) Let us consider how the excitatory impulse can reach the various fibrils (or sarcostyles) within a minute fibre. The impulse travels to each fibre by the terminal branch of a motor nerve; the actual motor end plate does not penetrate the fibre, but lies in close contact with the sarcolemma. While, therefore, it is easy to see that those fibrils lying close to the end plate might receive the stimulus, it is difficult to conceive how those on the opposite side of the fibre should be affected by it. There are three ways in which this might take place:—

- *(a)* The impulse might travel directly across the striation; since the striation is not a disc, but a spiral band which runs right along the fibre, the impulse would not cease when it reached the "other side" of the fibre, but continuing its path, would eventually travel right along the fibre.
- *(b)* On the other hand, the impulse might diffuse through the sarcoplasm; or
- *(c)* It might travel to the opposite side across the "striation," and thence longitudinally along the fibrils.

Now, neither the second nor the third method is very probable; the sarcoplasm in very slowly-moving muscles (*e.g.*, sluggish insect larvae) is very unevenly distributed; and moreover, there is never a direct continuity of the sarcoplasm (except along the spiral), successive portions being always separated by the membranes of Krause. Moreover, if the sarcoplasm was the transmitting agent, then we should expect the contractile wave, which is produced by the impulse, to travel in such a way that the fibrils in the neighbourhood of the motor end plate would be contracted along a greater part of their length than those on the opposite side of the fibre. The wave of contraction should travel not perpendicularly to the long axis of the fibre, but at a sharper angle

to it. When one observes the contraction waves in individual fibres, the former is found to be the case. The same is clearly seen in the beautiful figure of a contraction wave in *Dytiscus* muscle given by Schäfer.

If we accept the third of these possibilities, then we are faced with this same difficulty; the contraction wave would be expected to advance at an angle (probably of 45 degrees) with the longitudinal axis. Moreover, if the stimulus, according to this view, can travel across the "striation," then, since the "striations" really form a continuous spiral band, there is nothing to limit this passage of the stimulus, and it must continue to travel along the spiral; *i.e.*, we are driven to accept the first of the three possibilities.

(2) Since the contractile wave marks the path of the excitatory impulse, observations on fixed contractile waves, especially in the region of the motor end plate, should be of great value. It is seldom that one may have the good fortune to fix a muscle fibre at the moment that the impulse is leaving the end plate. Such a case has, however, been observed by Rollett, and his excellent figure is reproduced here. From it we see that the impulse, as marked out by

Contractile wave in muscle fibre of *Cassida equestris*, spreading from region of motor end plate. Note the travelling of the wave *across* the "striations," *i.e.*, along the spiral. (From Jordan and Ferguson's Histology, after Rollett.)

the contractile wave, is travelling "across the striation," and although the impulse has affected a number of fibrils in a direction *transverse to the length* of the fibre, there is no evidence to show that the stimulus has advanced *along* the fibrils. Rollett himself regarded the impulse as travelling across the striation in Krause's membrane. But since he was not aware of the arrangement of these striations in spirals he failed to put the obvious interpretation on his results.

Nevertheless, his figure shows clearly that the impulse is travelling across the striations, and it would appear that the striations beyond the region of the nerve end plate could not become affected, until the stimulus had travelled right across the fibre to the other side, and then back again along the spiral.

To demonstrate by direct observation the path of the impulse in such minute and rapidly acting tissues as muscle fibres is, of course, a matter of the

greatest difficulty, and it does not, at present, seem to me possible to give any evidence of a more direct nature than that stated above. Nevertheless, the deductions that can be made from the conclusion there reached are so suggestive, that they may almost be taken as the strongest evidence in favour of the view that the impulse actually travels down the spiral.

Before considering these, however, the path of the impulse may be further discussed. If, as seems probable, the impulse travels along the spiral, it becomes possible, to decide on what part of the spiral it travels. It is well known, that if the muscle from an animal be placed for about ten minutes in water, the muscle, while remaining capable of transmitting excitatory impulses, ceases to be able to respond to these by contracting. That part of the spiral which is concerned with contraction has evidently been destroyed; the conducting portion has remained unaffected. When histological preparations are made of a muscle thus treated, I find that the darkly-staining material has been destroyed; Krause's membrane remains perfectly intact. From this it would follow that it is the spiral Krause's membrane along which the stimulus travels within the muscle fibre, and that the dark material is concerned solely with contraction.

There is some other curious evidence in favour of this view. I have pointed out in my previous paper, that the motor end plate nuclei terminate in connection with Krause's membrane. In a remarkable paper by J. F. Fulton (1921), further evidence in favour of this view, as pointed out to me by Mr. H. R. Marston, is to be found. Fulton investigates the action of novocaine on the neuromuscular mechanism; he finds that this drug which acts physiologically, like curare, in paralysing the end plates, accumulates within the end plate nuclei, where its presence can be detected by forming subsequently brown diazo compounds with metaphenylenediamine. Since these nuclei lie in connection with Krause's membrane which, as I have shown above, is the only part of the spiral that remains in "water-logged" muscle; and since the nerve fibrils actually appear to communicate with these nuclei, and since, finally, novocaine, which paralyses the myoneural junction, acts directly on these nuclei, it would seem that the chain of evidence is fairly complete, which shows that the stimuli, travelling down the terminal nerve fibres, pass through the nuclei, and, entering Krause's membrane, travel along this membrane to the ends of the fibre.

This stimulus can be shown, by observing the contractile wave, to be capable of travelling in both directions within the fibre.

The velocity of a muscle wave, and therefore of the impulse which causes it, has been shown to be, in the frog, 3 to 4 metres per second (gastrocnemius muscle); in the mammalian muscle it travels at about 6 metres per second. It follows, since the fibres run along the longitudinal axis of these muscles, that the velocity of the impulse in a straight line along the fibres will be the same. Actually, however, since the impulse travels along the spiral Krause's membrane, the velocity will be very much larger than this, and the velocity with which it travels along the spiral can be calculated if we know the thickness of the fibre and the distance between the striations. These observations are not easy to make, as dead muscle must be avoided, and in living muscle the inherent elasticity of the fibres tends to cause considerable swelling and shortening of these. When, however, muscle tissue is teased up in Ringer's solution and all those fibres which are subjected to artificial stretching, or which have mechanically shortened, due to their elasticity, are excluded, measurements of the remainder should give the required data with considerable accuracy. I cannot confirm the statement often made that the fibres of a muscle show very great variations in their breadth; it should be remembered that, on account of their properties, muscle fibres are very deceiving in this respect.

When fibres, which are perfectly relaxed (but not stretched), are measured, we obtain the following data:—

Frog muscle: Distance between striations $= \frac{40}{13}\mu$; breadth of fibre $= 30\,\mu$.

Human muscle: Distance between striations $= \frac{8}{3}\mu$; breadth of fibre $= 68\,\mu$.

If d is the diameter of a fibre, L the distance between each successive striation, then the average distance that the impulses will travel in a single turn of the *double* helicoid will obviously be given by the following formula:—

$$\text{Actual distance} = \frac{\sqrt{\pi^2 d^2 + (2L)^2} + 2L}{2}$$

Since L is very small compared with d, we may write, actual distance $= \frac{\pi d + 2L}{2}$, approximately.

Since the component of this distance along the fibre is 2 L (*double* helicoid), the velocity of the excitatory impulse along the spiral will be $[\frac{\pi d + 2L}{4L} \times$ longitudinal component of the velocity], *where the longitudinal component is only approximately known.*

If we substitute numerical values for π, d, L, and the longitudinal component, we obtain: Velocity of muscle impulse in man=133 metres per second (approx.). Velocity of muscle impulse in frog=between 22 and 30½ metres per second.

It should be noted that the values are only approximate. The velocity of the muscle wave is by no means accurately known, and every error in this will be increased 8 or 20 times in the final result.

Now the measurements of the velocity of the nerve impulse in man show this to be about 123 metres per second (Piper); that of the frog 27 metres (Helmholtz).

So closely do these results approximate to the calculated values for the velocity of the excitatory impulse along the spiral, that we may say, with considerable confidence, that the velocity of the excitatory impulse along the spiral Krause's membrane, is equal to that of the nerve impulse.

Summary.

(1) The excitatory impulse travels through the fibre along the spiral Krause's membrane.

(2) It travels along this membrane with the velocity of a nerve impulse (frog and man).

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A BACTERIAL DISEASE DESTRUCTIVE TO FISH IN QUEENSLAND RIVERS.

By Professor T. Harvey Johnston, M.A., D.Sc., University of Adelaide, and Leith Hitchcock, Commonwealth Prickly Pear Laboratory, Brisbane.

[Read June 14, 1923.]

From time to time a very widespread and serious mortality has made its appearance amongst fresh water fish in localities extending from Anthony Lagoon, in the Northern Territory, to the Georgina River and Cooper Creek, together with their affluents, as well as the Queensland tributaries of the Darling basin, besides certain rivers entering the Gulf of Carpentaria and the Pacific coast of Queensland.

The senior author published a preliminary report in 1917, but the material submitted for examination, and on which the paper was based, was very scanty. In 1921, in conjunction with Mr. J. Bancroft, the result of a much more extended inquiry was made known.

The inaccessibility of the localities in which epidemics were reported to be in progress, and commonly the tardy arrival of information regarding their occurrence, seriously handicapped the investigation; consequently no observations were made during an epidemic, though on one occasion a visit was made to a locality within a few days of its disappearance.

The outstanding features of the epidemics according to newspaper reports as well as information received from many infected localities, were as follow:—(1) Certain species were specially affected, *e.g.*, Serranid perches (*Plectroplites ambiguus*, Richdsn.; *Therapon* spp.; *Oligorus macquariensis*, C. & V.); Clupeidae (*Nematalosa* sp.); and Catfishes (Plotosidae). (2) The epidemics occurred nearly always in the colder and drier part of the year (July and August), and in almost all cases the water was stagnant. (3) They ceased suddenly after rain had caused the streams and rivers to flow. (4) Affected fish were generally very fat, and death appeared to be due to an asphyxiation.

From the available evidence it appeared that the condition was not due directly to any of the following causes:—Dry weather; low temperature; overstocking of the waterholes representing the shrunken rivers and creeks; helminth or protozoal parasites. Though the fungus *Saprolegnia* was found commonly associated, it was regarded as being an organism which aggravated rather than caused the condition, and it was suggested that the epidemic was primarily due to the presence of some virulent bacterium whose multiplication and dissemination were favoured by a high acidity of the water, due to excess of carbon dioxide; in other words, by stagnant conditions. Though abundant bacteria were found in dead material in the Thomson River on the occasion of a visit, no cultures were made from the putrescent fish on account of lack of suitable facilities for carrying on bacteriological work at the time.

In these papers (1917, 1921) reference was made to the occurrence of dead fish floating down the lower Brisbane River during August and September, 1917-1918, and it was mentioned that the opinion of J. D. Ogilby, ichthyologist to the Queensland Museum, was that the use of dynamite by boating parties higher up the river was responsible for such mortality. Such a view was strengthened by an examination of a specimen submitted by that Museum, the disorganization of the viscera being such as would be caused by an explosion. On account of this, the Brisbane River epidemics were ruled out from further

consideration. From what we observed subsequently (1922) we feel sure that in addition to the illegal dynamiting of fish, which accounted for some of the mortality, there was also an epidemic in progress.

Towards the end of August, 1922, dead and dying fish were seen in large numbers floating down the Brisbane River in the vicinity of the Commonwealth Prickly Pear Laboratory, Sherwood, and on inquiry it was ascertained that the epidemic had been in progress for at least four weeks previously. Early in September the condition disappeared. We estimated that over 90 per cent. of the dead fish observed by us were the so-called Brisbane River perch, *Sciaena australis*, Gnthr., an estuarine species belonging to the Sciaenidae. The remainder consisted of catfish *(Tandanus tandanus* and *Neosilurus hyrtlii)* and a few John Dories *(Zeus faber*, L.). Moribund fish were seen to be swimming slowly on their sides on the surface of the water and unable to maintain their balance. A condition of acute dyspnoea seemed to be present. Hawks, fish-eagles, cormorants, and other birds were actively engaged in feeding on the fish; in fact, it was their activity which led us to discover that an epidemic was in progress.

Post-mortem examination revealed a condition resembling septicaemia. All the peritoneal blood-vessels were considerably distended, and the liver was putty-like, though its vessels were much engorged and showing plainly on the surface in places. The heart seemed normal, but the spleen was black and in many cases obviously necrosed. The gall-bladder was slightly enlarged and the kidneys congested. The intestine was empty except for the presence of a milky fluid. The marked fatty degeneration reported as occurring in material from the fresh waters of Western Queensland was not present in the Brisbane River specimens under examination.

Smears taken from the liver, kidney, and spleen of dying fish showed abundant, fairly large diplobacilli, and cultures made from the organs revealed the same organism. The latter was pleomorphic, its simplest form being obtained on agar, where it appeared as a micrococcus with scattered bacillary forms. In liquid media it occurred as a bacillus, reaching a maximum length of $2\,\mu$ by $85\,\mu$, though many appeared to be undergoing a constriction into cocci. The larger rods were often slightly curved. The arrangement was commonly that of diplobacilli. The organism was larger when growing in blood than on artificial media, and nearly always assumed the form of a diplobacillus.

It was gram negative and stained readily with the usual aniline dyes, a bipolar effect often being seen. Growth occurred on ordinary solid and liquid media at a titre of $+1\,5$ to $+0 5$ acid to phenolphthalein. Unless otherwise stated, the following remarks relate to growth in media at these two titres:—

Bouillon:—A good growth was present in 18 hours with clouding of the medium. After seven days a sediment was produced but no pigment, while after a lapse of 15 days a surface scum appeared and sedimentation was increased but without pigmentation.

Agar:—There was a good growth at $+1\,5$ and also at $+0{\cdot}5$, appearing dirty white by oblique light. Agar stabs showed no special features. On Agar plates the superficial colonies were round, slightly convex, with a well-defined outline, and when viewed microscopically by transmitted light appeared to be granular and to have a crenate margin. Well developed colonies were translucent and faintly yellowish.

Gelatin stab:—A filiform growth but no liquefaction, even in cultures a week old.

Blood serum:—Good growth; no liquefaction; no pigmentation.

Milk:—Good growth on litmus milk; no coagulation. On the first day the reaction was either unchanged or very faintly alkaline. On the second day the alkalinity was more marked, becoming pronounced on the succeeding day. The milk was not peptonised, even after four weeks.

Dunham's peptone solution:—Growth as in bouillon; no indol produced; no pigmentation.

Fermentation tests, from material grown on agar:—Observations were made daily for four days with each of the following: dextose, inosite, glucose, dextrin, saccharose, lactose, maltose, mannite, dulcite, arabinose, sorbite, adonite, amygdalin, laevulose, salicine, erythrite, raffinose, inulin. In no case did fermentation occur.

Temperature reaction:—The optimum when grown on agar was at about 25° C., while growth was slightly inhibited at 37° C.

Motility:—When examined direct from blood the organism was non-motile, but after 18 to 24 hours' growth in +1 5 bouillon at 25° C. showed a very feeble translatory movement when examined in hanging drop, and on the succeeding day the motility was more pronounced, but was never active. Most activity was obtained by using galactose broth as a medium.

Spore formation:—In old cultures the organism assumed an ovoid form suggestive of spore formation, but as the staining was quite uniform it probably does not form spores.

Inoculations:—A pure culture from an agar slope was diluted with sterile physiological saline and standardized to approximately 1,000 million organisms per C.C. A half C.C. of the mixture was injected into the peritoneum of a guinea pig without any apparent effect during the succeeding two months when the animal was kept under observation.

Another culture was similarly treated and made up to 500 million per C.C., 1 C.C. of the mixture being injected subcutaneously into a goldfish, which died in four days, while the controls all remained alive. This experiment was repeated on another goldfish, death occurring in four days. Post-mortem examination revealed conditions exactly similar to those seen in the naturally infected fish from the Brisbane River, and gram negative diplobacilli were isolated in pure culture from both of the experimental fish.

An agar culture was scraped into a large bowl containing four healthy goldfish, and in order to prevent the organisms from being washed away by the flowing water and to allow some degree of acidity in the water and thus stimulate stagnant conditions, the supply of fresh water (from the city water supply) was withheld for two days, the maximum acidity reached being 4 per cent. (using phenolphthalein as an indicator). On the third day the bowl was washed out and the normal supply of oxygenated water restored. On the eighth day all the fish spent most of their time at the surface, gulping air. On the fourteenth day one of the fish died. Post-mortem examination revealed a general septicaemic condition, and the gall-bladder was considerably enlarged. Blood smears showed the presence of some gram-negative diplobacilli. Cultures were made from the heart and spleen, and the organism recovered from them. The remaining fish eventually became apparently normal.

This evidence showed that when introduced directly into goldfish the organism was lethal, but when infection occurred through the alimentary canal or gills the effect was more slowly produced and might not be so virulent.

The growth reactions of the diplobacillus showed that a high degree of acidity in the water favoured its propagation. Consequently any conditions which caused either stagnation of water (*i.e.*, insufficient aeration) or a considerable increase in the animal life of a mass of water (*e.g.*, dwindling of a river into a series of waterholes and the consequent increased density of the fish population in such waterholes) would favour the growth of the organism. Then, again, the increased density of the fish population would favour the outbreak of an epidemic which would probably cause the greatest havoc amongst the least-resistant species.

We have no proof that the organism found by us in the Brisbane River is the same as that producing the epidemics in Western Queensland rivers, but

the fact that such outbreaks have, at least on several occasions, synchronised in the two localities, and that weather conditions have been more or less similar, is strong evidence in favour of assuming that the organisms concerned in the two cases are specifically identical. It must be pointed out, however, that in the Brisbane River outbreak, all the diseased fish examined were estuarine, and that we did not know in what locality infection occurred. It must have been many miles up stream, as the river during winter is distinctly salty (the rainfall being a summer one), and therefore probably more or less alkaline where the diseased fish were collected, but higher up stream, beyond the reach of the tide, conditions would be different. Though the diseased fish were estuarine, the organisms obtained from them caused a similar disease when introduced into a fresh water fish, *e.g.*, goldfish. The causal organism appears to us to be new to science, consequently we have designated it *Bacillus piscivorus.*

Hofer (1906) gave a short account of several bacterial diseases of fresh water fish, including Salmonidae, but the Brisbane organism is readily separable from all those referred to by him excepting *Bacterium salmonis-pestis*, Paterson (1903), the cause of the well-known salmon disease (Drew, 1909). The latter is an actively motile, non-sporing, gram-negative, short, thick bacillus or diplobacillus which liquefies gelatin and coagulates milk with a slow acid reaction. It is pathogenic for fish, especially the Salmonidae. It thus differs from *B. piscivorus* in its reactions towards milk and gelatin.

Another organism to be considered is *B. truttae*, Marsh (1903), which causes an epidemic amongst American Salmonidae. It is a gram-positive, non-motile, short bacillus, or diplobacillus, which grows best at a titre ranging from neutral to +0·5 acid to phenolphthalein, and at the latter titre will liquefy gelatin, though not at a titre of +1·5 when growth becomes practically inhibited. It liquefies blood serum; does not clot milk but peptonises it, and the reaction is neutral or faintly acid. In bouillon cultures (+0·5) after eighteen hours there is no clouding but there is sedimentation; while after 10 to 15 days a characteristic brown colour appears in the medium and the sediment becomes dirty brown, changing with age to dark brown. The colonies on agar change from greyish-white to greyish-brown on and after the third day. The Brisbane bacterium differs from *B. truttae* in its reaction to gram, its growth on agar (the former growing well on +1·5 agar, as well as on +0·5), absence of pigmentation in old colonies, distinct clouding of bouillon in 18 hours but no appearance of a brown colour even after four weeks at room temperature (20°-22° C.), effect on gelatin and blood serum as well as on milk. Moreover, *B. truttae* is reported to be killed by exposure to a temperature of 37° C. for 17 hours, whereas *B. piscivorus* is not.

The cultural reactions of the Australian organism resemble those of *Bacillus fecalis-alkaligenes* in regard to growth in bouillon and gelatin, the non-fermentation of all sugars and gram staining. The latter is very actively motile and an alkaline reaction is marked on the first day of growth in litmus milk. The fermentation reactions and the active motility readily distinguish *B. piscivorus* from *B. typhosus* and its allies.

Two bacterial organisms have already been described from Australian marine fish by Grieg Smith (1900), *viz.*, *B. piscicidus bipolaris* and *Vibrio bresimae.* The former liquefies gelatin, coagulates milk, is actively motile, forms spores, and is gram positive; while the latter liquefies gelatin, turns litmus milk acid, bleaching it in seven days, and gives a slight indol reaction after seven days' growth in bouillon.

If Castellani and Chalmers' (1919) classification of bacteria be accepted, then the name *Alcaligenes piscivorus* should be applied to the new organism, as its reactions place it in their genus *Alcaligenes*, near *B. fecalis.*

Organism.	Bouillon.	Gelatin.	Litmus Milk.	Blood serum.	Indol.	Gram.	Motility.	Spores.
B. piscivorus	Clouding	Not liquefied	Alk. 2nd day	—	—	—	+ feeble	—
B. truttae	No clouding Colour in + 5 acid	Not liquefied +1 5 acid Liq. + 5 acid	Acid. No clot. Peptonised	Liquefied	—	+	—	—
B. f. alkaligènes	Clouding	Not liquefied	Alk. 1st day		—	—	+ +	—
B. salmonis pestis		Liquefied	Clot, slowly becoming acid		—	—	+	—
B. pisc. bipolaris	Clouding	Slowly liq.	Coagulation. Clot dissolved		—	+	+ +	+
Vibrio bresimae	Turbidity	Liquefied	Acid, finally bleached		+		+	—

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A BACTERIOSIS OF PRICKLY PEAR PLANTS (OPUNTIA spp.).

By Professor T. Harvey Johnston, M.A., D.Sc., University of Adelaide, and L. Hitchcock, Commonwealth Prickly Pear Laboratory, Brisbane.

[Read June 14, 1923.]

Whilst the senior author was in Miami, Southern Florida, in 1920, on behalf of the Commonwealth Prickly Pear Board, making inquiry regarding diseases and insect enemies of prickly pears, his attention was drawn by Mr. Simmonds, officer in charge of the Plan Introduction Garden belonging to the Federal Department of Agriculture, to a few very sickly Opuntia plants. Their appearance suggested a bacteriosis. The infected specimens were *O. tomentella*, from Guatemala, in Central America, and *O. ficus-indica*, from Columbia, South America. Prior to his departure from U.S.A. he arranged for material to be sent across later by one of his colleagues, Mr. J. C. Hamlin. Specimens collected by the latter in Florida in March, 1921, were eventually received at the Prickly Pear Laboratory in Brisbane as dried fragments, complete disintegration having occurred *en route*. Cultures were made and the various bacteria obtained were sorted out, the causal organism being ultimately obtained.

The disease is first recognizable by the appearance of a rounded blackish area, a bright purple margin being commonly seen adjacent to a narrow chlorosed region separating it from the uninvaded plant tissue. The lesion is at first generally much more obvious on the one surface, *i.e.*, the originally infected surface, but soon the disease reaches the opposite portion of the cladode and the lesion spreads. The underlying parenchyma becomes completely disintegrated and the cuticle may sink somewhat. In other cases, the gas formed as a result of the organism's activity causes the cuticle to bulge out, the gas collecting below it.

As the disease progresses the distinct purplish colouration close behind the advancing edge of the lesion becomes very marked. The parenchymatous tissue ultimately disintegrates into a greenish-brown, or even dark-brown, slimy, foetid liquid. The disease does not spread along the vascular bundles, but evidently advances through the breaking down of parenchyma cells. Fully disintegrated segments may resemble dull-green or grey-green cushions containing liquid and gas, but as there is frequently some opening by which these products of putrefaction can escape, only a dried cuticle surrounding the vascular strands may remain.

The disease will not travel from an infected segment to that above or below it, the organism being unable to utilize the vascular bundles. It is then limited to the parenchyma of the inoculated segment. Under certain conditions of climate the progress of the malady is so slow that the protective mechanism of the invaded cladode is able to limit the lesion, the diseased portion then drying out and collapsing. Such happens under cold and dry conditions. When temperature and moisture are suitable (as occurs in Queensland during the hot, moist, summer months, January to March) the disease advances too rapidly for the plant to circumscribe it. A lesion which has become limited by the activity of the plant cells not infrequently may subsequently extend through the surrounding tissues if weather conditions be favourable, when the destruction of part or whole of the segment may result. The effect on the stems is somewhat similar, but the disease spreads very slowly unless assisted by some inoculating agent such as a boring insect larva.

The organism which appears to be the first bacillus to be described as attacking Cactaceae, and which we name *B. cacticidus*, will grow on all ordinary laboratory media, but when grown in bouillon or agar its virulence is very considerably diminished. The greatest virulence is manifested by organisms which have been grown on a prickly pear decoction for two days at room temperature 20-25° C., and in such fluid there is a production of abundant gas. The decoction was made by boiling sliced fragments in distilled water until a very viscid extract was produced; it was then strained and sterilized.

If organisms from such a culture medium be inoculated into the parenchyma in quantity, incubation at 37° C. for 48 hours commonly results in the almost complete disintegration of the segment, a very pronounced effect being obtainable even within 24 hours. On the other hand, inoculations from agar or bouillon cultures failed to cause the disease in *Opuntia inermis, O. stricta*, and *O. megacantha*, even after a long interval, whereas segments of *O. tomentosa* inoculated at the same time from the same cultures and kept under the same conditions, became completely disintegrated in from seven to fourteen days, while the slimy liquid produced by the decomposition of the last-named species, when inoculated into the other three Opuntias, produced a rapid decay which destroyed the infected segments in about seven days during midsummer. Diseased material desiccated for months retains its capability to reproduce the malady if inoculated into fresh segments of prickly pear.

Attempts to produce infection through the stomata either by smearing or by spraying organisms from active cultures over the uninjured surfaces of segments failed, while detached cladodes, if allowed to dry sufficiently to heal the scar at the joint where broken from the parent segment, did not become infected when the lower end of such segment was immersed for weeks in the liquid from decomposed material, though such liquid readily produced disease if an injury were made in the submerged part of such segment.

The organism is an actively motile, gram-negative, aerobic, and facultative anaerobic bacillus. When grown on agar it is almost coccoid, measuring about 8 μ in diameter, but in liquid media it forms short rods occurring singly or in pairs and measuring 1 3 μ by 8 μ. Neither spores nor capsules were observed. Smooth greyish-white colonies are produced on +1 5 acid agar slopes (Ayres' scale), while on poured plates they are round, raised, wet, shiny, and dirty white, inclining to yellow.

Inoculation from a 24 hours' broth culture gave an acid reaction on the first day, and persisting for at least four days, in glucose, saccharose, mannite, and salicine, but none in maltose, lactose, dulcite, and arabinose. The reaction in litmus milk caused an acid clot on the second day, the clot remaining unchanged at the end of a week.

The optimum temperature was found to be between 28° and 30° C., which is strong evidence in favour of the view that its native home is the tropical portion of America, probably in the vicinity of the Carribean Sea.

It was ascertained experimentally that the cactus "moth borers" *Melitara prodenialis*, from Florida, and *M. junctolineella*, from Texas, as well as another Pyralid (Phycitid) moth, *Mimorista flavidissimalis*, from Texas, were all able during their caterpillar stages to transmit the organism from diseased to sound portions of the same or other plants, the bacteria probably being carried on the hairs and skin of the larvae and deposited in the injuries or tunnels made by them. Under such circumstances, the lesions occasioned by the insects are greatly aggravated; in fact, in the case of very young larvae (first instar) of *Melitara*, the destruction and liquefaction of plant tissue may be so rapid as to imprison or even drown them while in their tunnels. This does not happen with older caterpillars which migrate from the decomposing segment and carry the

infection to the next one invaded by them. The organism would also certainly be transmitted by similar Pyralid larvae *(Cactoblastis cactorum* and *C. bucyrus)* which attack cacti in South America.

The boring larvae of the cactus longicorn beetles, *Moneilema* spp., also may act as transmitters as a result of contamination, and thus their action in destroying old stems and underground parts of prickly pear plants may be accelerated.

The common ferment flies (Drosophilidae) which invade ripe and rotting fruit, decaying vegetation, etc., in Brisbane, are attracted to decomposing prickly pear, in which they readily breed and on which they feed. The flies are capable of acting as transmitters of the disease by infecting injured surfaces of segments.

A series of experiments was carried out, using the following four species of cactus bugs: *Chelinides vittigera* (Texas), *C. vittigera* [?] (Florida variety), *C. canyona*, and *C. tabulata*, which were allowed to feed on obviously diseased segments for a few days and then transferred to healthy segments, but in no case did infection result. Perhaps the outside of the rostrum of the bugs may have become cleansed during the act of puncturing the tissues of the plant to which they had been subsequently transferred.

The effect of *B. cacticidus* on a variety of crops and fruits was tried out in the laboratory. In the case of growing plants the surface of leaves was scratched and material from an active culture was placed in the injuries, but no disease developed. The plants so tested were wheat, barley, oats, maize, and legumes Direct inoculation as well as attempted infection of scratches was tried in the case of banana plants, but without success. The organism was inoculated, but failed to produce any disease, in the following fruits: apple, pear, plum, peach, banana, mango, pineapple, custard apple; also in carrots, parsnips, beet, turnips, cabbage, cauliflower, lettuce, and sugar-cane. It was found that hard cucurbitaceous fruits such as the pumpkin were not affected, but that the more pulpy kinds such as squashes, melons, and marrows were, the parenchyma completely breaking down into a liquid as a result of deep inoculation even from an agar culture. Under ordinary conditions of temperature potatoes were not affected by inoculation, but if kept in an incubator at 37° C. then decomposition was produced.

The disease was not encountered anywhere in the United States, except in Miami, Florida, either by the senior author or by his colleague, Mr. J. C. Hamlin. The garden from which the original material was obtained is primarily utilized for growing tropical agricultural plants and various kinds of citrus fruits. As any lesion on fruits would soon be observed, and if unknown to those in charge, would be submitted for expert examination, it is reasonable to assume that citrus fruits are not susceptible to attack.

It seems as if *B. cacticidus* may play a very important rôle in prickly pear eradication in Australia during the warm moist summer, by becoming associated (as a result of contamination) with the larval stages of the moths *Melitara* and *Mimorista* especially, and, to a less extent, the adult Drosophilid flies and the larvae of *Moneilema* beetles, but without these aids the organism will at most produce only a local lesion on the plant, acting as a wound parasite.

The following species of prickly pear occurring naturalized in Australia are susceptible to attack, viz., *Opuntia tomentosa, O. inermis, O. stricta, O. aurantiaca, O. megacantha, O. ficus-indica,* and *O. monacantha (vulgaris)*. It can be safely assumed that the remaining species which occur more sparsely in our continent are also susceptible.

NEW AUSTRALIAN MICRO-LEPIDOPTERA.

By A. JEFFERIS TURNER, M.D., F.E.S.

[Read July 12, 1923.]

Fam. GLYPHIPTERYGIDAE.

Gen. **Epithetica**, nov.

ἐπιθετικο, active.

Tongue present. Labial palpi moderately long, recurved, scarcely reaching vertex, rather stout, laterally compressed, slightly rough-scaled; terminal joint shorter than second, obtusely pointed. Maxillary palpi obsolete. Antennae about ⅗, without pecten; in male simple. Thorax with a posterior crest. Middle tibiae much thickened with scales towards apex. Posterior tibiae clothed with long loose hairs above and beneath. Forewings with 2 from shortly before angle, 7 and 8 coincident, 11 from before middle of cell. Hindwings broadly ovate, cilia ⅛; 3 and 4 connate or stalked, 5, 6, 7 separate, parallel.

This interesting genus has neuration identical with *Hierodoris*, Meyr., from New Zealand, but differs in the long-haired posterior tibiae and presence of a thoracic crest. It is probably an independent development from *Heliostibes*, Zel., also from New Zealand, but not, so far, known from Australia.

Epithetica typhoscia, n. sp.

τυφοσκιος, darkly shaded.

♂, 14-15 mm. Head fuscous; face grey. Palpi pale-grey irrorated extensively with blackish, which sometimes forms transverse rings. Antennae fuscous annulated with pale grey; in male simple. Thorax dark fuscous; patagia and a pair of lateral spots brown. Abdomen dark fuscous. Legs dark fuscous; posterior tibiae and tarsi partly whitish-ochreous. Forewings suboblong, posteriorly dilated, costa slightly arched, apex rounded-rectangular, termen sinuate beneath apex, slightly oblique; dark fuscous; a suffused brown subbasal fascia; a brown incomplete fascia from dorsum before middle, reaching ¾ across disc, edged anteriorly with grey; immediately after this a suffused grey fascia from midcosta to beyond middorsum, in it a fine black line from ⅗ costa to ¾ dorsum; another grey fascia containing a dark line from ¾ costa to termen above tornus; terminal edge fuscous preceded by a grey line; cilia fuscous. Hindwings dark fuscous; cilia fuscous.

New South Wales: Lismore, in October, two specimens.

SAGALASSA HOMOTONA, Swin.

Balataea homotona, Swin., Cat. Oxf. Mus., i., p. 36, pl. ii., f. 18.

♂, 22 mm. Head dark fuscous; face partly ochreous. Palpi 3½; dark fuscous, lower surface whitish-ochreous. Antennae dark fuscous; in male with thickened stalk, pectinations 2. Thorax fuscous. Abdomen dark fuscous with white subbasal and median transverse lines on dorsum; beneath irregularly mixed with white. Legs [middle pair absent] dark fuscous; dorsum of tibiae except base and posterior third whitish-ochreous; apices of tibiae and first two tarsal joints whitish. Forewings narrowly oblong, dilated beyond middle, costa sinuate, apex rounded, termen obliquely rounded; dark fuscous; costa narrowly ochreous to ⅗, thence whitish; a few ochreous scales above ⅗ dorsum; an elongate-oval longitudinal ochreous spot in middle of terminal area; cilia

fuscous. Hindwings with termen nearly straight; dark fuscous; costa broadly ochreous-whitish; central area of disc scaleless, transparent; cilia fuscous.

Described from the type in Oxford Museum, labelled "Australia." This species is otherwise unknown to me.

Sagalassa poecilota, n. sp.

ποικιλοτος, variegated.

♂, ♀, 18-19 mm. Head brownish-grey. Palpi porrect; second joint with an apical tuft of hairs above; terminal joint with apex obtusely rounded; whitish-ochreous partly suffused with fuscous. Antennae brownish-grey mixed with fuscous; in male serrate with moderate ciliations 1. Thorax brownish-grey, in centre fuscous. Abdomen dark fuscous, apices of segments ringed with ochreous. Legs fuscous; tarsal annulations and hairs on posterior tibiae ochreous. Forewings rather narrow, not dilated, costa straight to middle, thence arched, apex rounded, termen obliquely rounded; brownish-grey towards base suffused with ochreous-whitish, beyond middle purple-tinged; an inwardly oblique fuscous-brown fascia from midcosta to ⅓ dorsum, narrow on costa, gradually broadening to dorsum; an obscure, suffused, subterminal fuscous line, sharply angulated inwards in disc; some reddish apical suffusion; a fuscous terminal line; cilia grey. Hindwings with termen gently rounded; dark fuscous; a median orange spot before middle, and a second, smaller, between it and dorsum; cilia pale orange.

North Queensland: Kuranda, three specimens, received from Mr. F. P. Dodd, bred from the fruits of *Calamus australis*.

TORTYRA DIVITIOSA, Wlk.

Saptha divitiosa, Wlk., Cat. Brit. Mus., xxx., p. 1015.

Badera nobilis, Feld., Reise Nov., pl. 139, f. 9.

Tortyra divitiosa, Meyr., Proc. Linn. Soc. N.S. Wales, 1907, p. 99.

North Queensland: Claudie River, one specimen, taken by Mr. J. A. Kershaw; also from New Guinea and Moluccas. Not previously recorded from Australia.

Simaethis lygaeopa, n. sp.

λιγαιωπος, dark.

♂, 16 mm. Head fuscous-brown thinly sprinkled with fine whitish points. Palpi white; second joint with three blackish rings; terminal joint with three blackish rings including apex. Antennae white sharply ringed with black; ciliations in male 4. Thorax fuscous-brown with fine whitish points. Abdomen fuscous. Legs fuscous; tarsi annulated with whitish. Forewings broadly triangular, costa strongly arched, apex obtusely angled, termen slightly bowed, slightly oblique; dark fuscous-brown sprinkled with whitish scales, the absence of which leaves dark markings; a subbasal fascia; another narrower at ⅛, followed by a whitish costal dot; a broad fascia from costa before middle, contracting in disc to a dentate line, which finally curves outwards to beyond middle of dorsum; beyond this are two whitish costal dots, between which originates a fine line, which is strongly bent outwards towards termen, before which it is thrice dentate, then bent inwards, and continued parallel to termen, but does not reach dorsum; beyond and parallel to this is a subterminal line, which does not reach costa; cilia fuscous with a black basal and whitish terminal line. Hindwings with termen only slightly bowed; fuscous; cilia fuscous, apices paler.

Queensland: National Park (3,000 feet), in December, two specimens; New South Wales: Lismore, in January.

Fam. HYPONOMEUTIDAE.

Zelleria orthopleura, n. sp.

ὀρθοπλευρος, with straight costa.

♂, ♀, 13-15 mm. Head grey. Palpi slender; whitish. Antennae grey. Thorax grey. Abdomen pale grey. Legs grey; posterior pair and middle tarsi whitish. Forewings narrow, costa straight, apex rounded, termen and dorsum continuous, straight; grey; numerous fuscous dots, some on basal half of costa, a subterminal and a subdorsal series in disc; a suffused inwardly oblique mark in disc before middle, and another on middorsum; cilia grey with some fuscous irroration around apex. Hindwings lanceolate; pale grey; cilia 3; pale grey.

Nearest *Z. aracodes*, Meyr.

Queensland: Brisbane, in August; Coolangatta, in September; Charleville, in September; four specimens.

Zelleria euthysema, n. sp.

ευθυσημος, with straight marking.

♂, 16-18 mm Head and palpi white Antennae grey, whitish towards base. Thorax white; patagia orange. Abdomen pale grey. Legs grey; posterior pair whitish. Forewings lanceolate, costa strongly arched, apex acute, termen and dorsum continuous, straight; white; a slender yellow subcostal line to $\frac{2}{3}$; a yellow or orange median streak from base to above tornus, in posterior half edged above with grey; a suffused streak of grey irroration from beyond middle of disc to apex, broadening posteriorly; cilia white irrorated with grey, sometimes tinged with yellow beneath apex, on dorsum grey-whitish. Hindwings broadly lanceolate; pale grey; cilia $1\frac{1}{2}$, grey-whitish.

Queensland: Crow's Nest, near Toowoomba, in October; Stanthorpe, in February; two specimens.

Zelleria panceuthes, n. sp.

παγκευθης, well concealed.

♂, 12 mm. Head fuscous-brown. Palpi whitish, external surface mixed with fuscous. Antennae fuscous. Thorax fuscous-brown. Abdomen grey. Legs fuscous; posterior pair grey. Forewings narrow, costa nearly straight, apex pointed; fuscous-brown with fuscous irroration; a series of minute fuscous dots on costa from base to middle; a paler dorsal streak suddenly broadening at $\frac{1}{4}$ so as to extend beyond middle of disc, this extension is bounded anteriorly by a defined oblique line, posteriorly it is suffused and undefined; cilia grey, on and near apex fuscous. Hindwings lanceolate; grey; cilia $3\frac{1}{2}$, grey.

Queensland: National Park (3,000 feet), in January, one specimen.

Zelleria perimeces, n. sp.

περιμηκης, elongate.

♂, ♀, 20-22 mm. Head, palpi, antennae, and thorax grey. Abdomen ochreous-grey. Legs fuscous; posterior pair grey. Forewings moderately narrow, costa slightly arched, apex obtusely pointed; grey with a few fuscous scales; some scattered fuscous dots, more numerous towards base; an inwardly-oblique fuscous line from $\frac{1}{3}$ costa to $\frac{1}{4}$ dorsum more or less developed; a brownish-fuscous apical spot; cilia grey, around apex fuscous. Hindwings broadly lanceolate; grey; cilia 1, grey.

Victoria: Mount Macedon, near Gisborne, in March, five specimens received from Mr. Geo. Lyell, who found the pupae beneath the thin bark of smooth gum *(Eucalyptus)* trunks. Type in Coll. Lyell.

Xyrosaris acroxutha, n. sp.

ἀκροξουθος, tawny at the apex.

♂, 15 mm. Head white. Palpi fuscous, inner surface whitish; second joint slender, not tufted; terminal joint dilated with long hairs obscuring apex. Antennae grey. Thorax whitish with some grey irroration. Abdomen grey; tuft ochreous-whitish. Legs fuscous; posterior pair whitish. Forewings narrow, costa nearly straight, apex pointed, termen and dorsum continuous, straight; grey with some fuscous irroration; towards dorsum suffused with whitish; 4 or 5 fuscous dots on basal third of costa and two subcostal dots beyond this; an interrupted blackish line on apical end of costa, and some blackish scales on terminal edge; cilia orange-brown with two postmedian fuscous lines, on dorsum grey. Hindwings broadly lanceolate; grey; cilia $1\frac{1}{2}$, grey.

Not unlike *X. dryopa*, Meyr., but palpi not tufted on second joint.

Queensland: National Park (2,500 feet), in December, one specimen.

Prays parilis, n. sp.

Parilis, similar.

♂, ♀, 11-13 mm. Head and palpi white. Antennae grey. Thorax white; anterior edge fuscous. Abdomen grey. Legs grey; posterior pair whitish. Forewings rather narrow, costa nearly straight, apex rounded, termen very oblique; white; markings fuscous; a series of strigulae on basal third of costa, and another on basal third of dorsum, some dot-like, others produced into disc; a moderate fascia from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum, sometimes divided on costa into strigulae separated by white dots, constricted in middle; a subapical costal spot, and a large spot on termen above tornus, sometimes connected; cilia grey. Hindwings and cilia grey.

Nearest *P. inscripta*, Meyr., but with white thorax and only one fascia on forewing.

Queensland: Brisbane, in November and December, three specimens.

Prays amblystola, n. sp.

ἀμβλυστολος, in dull clothing.

♂, 14 mm. Head and thorax fuscous-brown. Palpi and antennae fuscous. Abdomen and legs fuscous. Forewings narrow, dilated posteriorly, costa nearly straight, apex rounded, termen very oblique; fuscous-brown; a median whitish streak from $\frac{1}{4}$ to $\frac{3}{4}$, suffusedly connected with middorsum, and again with tornus; some patchy whitish suffusion on apical portion of disc; cilia brown. Hindwings grey, thinly scaled; cilia grey.

New South Wales: Mount Kosciusko (3,500 feet), in January, two specimens.

Charicrata sericoleuca, n. sp.

σηρικολευκος, silky-white.

♀, 13-14 mm. Head, palpi, antennae, and thorax white. Abdomen pale grey. Legs white; tarsi with fine fuscous annulations. Forewings narrow-oval, costa slightly arched, apex round-pointed, termen very obliquely rounded; shining white faintly tinged with ochreous and sparsely irrorated with pale fuscous, which forms fine transverse strigulae, near apex and termen this is replaced by dark fuscous; cilia ochreous-whitish, sometimes with fuscous apical dots. Hindwings and cilia white.

Queensland: National Park (2,500 feet), in January; New South Wales: Lismore, in October, two specimens.

HYPONOMEUTA INTERRUPTELLUS, Saub.

Teinoptila interruptella, Saub, Semp Schmet. Phil., ii, p. 701, pl. 66, f. 16.
Yponomeuta interruptellus, Meyr, Proc. Linn. Soc. N.S. Wales, 1907, p. 77.

♂, 20 mm. Head whitish with a dark-fuscous central spot on crown. Palpi dark fuscous, inner surface whitish. Antennae dark fuscous, towards apex whitish. Thorax whitish with a posterior fuscous spot. Abdomen dark fuscous, under-surface whitish Legs, dorsal surface fuscous, ventral whitish. Forewings elongate, costa gently arched, apex round-pointed, termen obliquely rounded; dark fuscous with three irregular whitish blotches; first subbasal to 3, with two circular indentations above and beneath; second postmedian, containing a circular fuscous dot; third smaller, its lower edge touching termen; cilia fuscous. Hindwings and cilia dark fuscous.

Not having seen the description of this species I cannot be sure of its identification, but from the meagre particulars given by Mr. Meyrick it seems probable.

North Queensland: Claudie River, in February, one specimen taken by Mr. J. A. Kershaw; also from New Guinea and Phillipine Islands.

HYPONOMEUTA MYRIOSEMUS, Turn.

This species and the following are very closely allied, and both are slightly variable; probably, however, they are really distinct. My original material consisted of three examples, of which two are *paurodes*, only the type being *myriosemus*. As I have now more examples, I think it desirable to redescribe them.

♂, 24-30 mm.; ♀, 30-32 mm. Forewings with costa nearly straight to middle, thence gently arched, apex rounded-rectangular, termen nearly straight; white with blackish markings; costal edge towards base blackish; a series of 4 or 5 dots on basal ⅓ of costa, sometimes followed by a sixth dot; beyond this a subcostal series of 1, 2, 3, 4, or 5 dots; a median series of 3 or 4 dots in basal ⅓, the first basal, second and third on fold; a submedian series of 2 or 3 dots in apical ½; a subdorsal series of 4 or 5 dots; a dot on tornus, a variable number of terminal dots, sometimes partly confluent, sometimes those near apex partly obsolete; terminal edge beneath apex blackish; cilia white with a grey or fuscous postmedian line sometimes extending to apices. Hindwings grey, towards base suffused with whitish; cilia grey, apices sometimes whitish, on tornus and dorsum whitish.

Queensland: Duaringa (Meyrick); Brisbane; Mount Tambourine, in November and January; Coolangatta, in October; five specimens; New South Wales: Katoomba (Meyrick).

HYPONOMEUTA PAURODES, Meyr

Yponomeuta paurodes, Meyr., Proc. Linn. Soc. N.S. Wales, 1907, p. 150.

♂, 18-24 mm.; ♀, 20-26 mm. Forewings more arched towards apex than in *myriosemus*, apex and termen more rounded; white with blackish markings; costal edge towards base blackish; a costal series of 4 or 5 dots on basal ⅓; a subcostal series of 3 (rarely 4) dots beyond these; a median series of 4 dots in basal ⅓, the first basal, second and third on fold; two submedian dots in apical half; a subdorsal series of 3 dots (one example has a minute fourth dot on one side only); a dot on tornus, a second on termen below middle, sometimes two minute dots between these; upper part of termen without dots and fuscous edge (one example has two minute dots arranged longitudinally before and at a short distance from apex on one side only); cilia wholly white. Hindwings grey, towards base suffused with whitish; cilia white, bases sometimes grey but not on tornus and dorsum.

The best points of distinction from *H. myriosemus* appear to be the shape of the forewings, their wholly white cilia, the absence of blackish dots on terminal edge beneath apex, and the almost invariable restriction of the subdorsal dots to three.

North Queensland: Townsville, in July and August (Dodd); Queensland: Brisbane, in August; Coolangatta, in January and April; ten specimens.

Atteva hesychima, n. sp.

ἡσυχιμος, quiet.

♀, 32 mm. Head orange. Palpi fuscous; second joint with basal and apical whitish rings. Antennae grey. Thorax whitish; a fuscous spot on base of each patagium and another just before posterior apex. Abdomen whitish; a large fuscous spot on dorsum of each segment. Legs grey; posterior pair grey-whitish. Forewings elongate, slightly dilated posteriorly, costa strongly arched, apex rounded, termen obliquely rounded; whitish; a broad grey costal streak from base, narrowing to a point at ⅘; a broad grey dorsal streak from ¼, narrowing to a point before tornus; a terminal fascia, broadest at apex, not reaching tornus, grey, near apex suffused with fuscous; a fuscous spot on base of costa, one above and another beneath fold near base, two on edge of costal streak at middle and ⅘, one on fold at ⅓ resting on dorsal streak, another at ⅔ in a line with this, one posterior and between the last and second subcostal spot, a third subcostal, three close together in a line above tornus; cilia fuscous-grey. Hindwings broader (1½); grey; cilia grey-whitish becoming whitish on tornus and dorsum.

In the type 8 and 9 of forewing are stalked on one side, separate on the other.

Queensland: National Park (2,500 feet), in December, one specimen.

Ethmia olbista, n. sp.

ὀλβιστος, most happy.

♂, ♀, 16-20 mm. Head, palpi, and thorax blackish. Antennae blackish, in male minutely ciliated. Abdomen blackish; tuft ochreous; underside in female ochreous towards apex. Legs blackish; hairs on posterior tibiae yellow. Forewings elongate-oval, costa strongly arched, apex rounded, termen obliquely rounded, dark fuscous; a blackish discal dot in middle at ⅔, more or less distinct; rarely this is preceded by a similar dot before middle; cilia dark fuscous. Hindwings elongate, as broad as forewings; orange-yellow; a large blackish apical blotch; cilia blackish, towards tornus and on dorsum yellow.

Queensland: Bunya Mountains (3,500 ft.), in October, seven specimens. This pretty little species was rather common on the upper slopes of Mount Mowbullan.

TANAOCTENA OOPTILA, Turn.

Queensland: National Park (2,500 feet), in December, one worn specimen, which I refer to this species; the first discal dot is expanded into a small fuscous blotch. In this genus the antennae of male are bipectinated (not unipectinated as stated in my diagnosis), and the forewings have 8, 9, 10 stalked.

Gen. **Lissochroa**, nov.

λισσοχροος, smooth skinned.

Head smooth with some loose anterior scales between antennae. Tongue present. Palpi smooth, slender, porrect; terminal joint shorter than second. Maxillary palpi obsolete. Antennae about ⅘, basal joint long and flattened to form a rudimentary eyecap, pecten strongly developed. Posterior tibiae smooth. Forewings with 2 from shortly before angle, 3 and 4 stalked from angle, 5 from

shortly above angle, 6 from middle, 7 to termen, 8 and 9 stalked, 10 from shortly before angle, 11 from before middle. Hindwings with 3 and 4 coincident, 5, 6, 7 separate, parallel, discocellulars very oblique between 7 and 5.

Intermediate between *Chionogenes*, Meyr., and *Sphenograptis*, Meyr.

Lissochroa argostola, n. sp.

αργοστολος, robed in white.

♀, 16 mm. Head, palpi, and thorax white. Antennae grey, towards base white. Abdomen grey. Legs whitish. Forewings ovate-lanceolate, costa moderately arched, apex acute, termen very oblique; shining white with a few scattered fuscous scales; a fuscous spot on costa at $\frac{1}{4}$, followed by three equidistant spots connected by slight fuscous irroration; a fine interrupted fuscous terminal line; cilia white, apices fuscous. Hindwings elongate-ovate; whitish-grey; cilia $\frac{3}{4}$; whitish-grey.

Queensland: Brisbane, one example taken many years back; New South Wales: Lismore, in July.

Fam. GRACILARIADAE.

Epicephala stephanephora, n. sp.

στεφανηφορος, wearing a crown.

♂, ♀, 11-13 mm. Head ochreous on crown; face and palpi white. Antennae pale grey, darker towards apex. Thorax white. Abdomen grey. Legs whitish; anterior and middle tibiae and tarsi annulated with fuscous. Forewings grey; a broad white dorsal streak, its upper edge rather irregular; a triangular white costal spot at $\frac{1}{3}$, prolonged on costal edge towards base; two white costal spots beyond middle, followed by a short streak; a leaden-metallic transverse line cuts off a small apical area, which is white, and contains a large central fuscous spot; cilia white with a complete basal and a short apical blackish line, on dorsum grey. Hindwings narrow-lanceolate; grey; cilia 5, grey.

Easily recognized by the ochreous crown.

Queensland: Brisbane, in April; Stradbroke Island, in December; two specimens.

Acrocercops pertenuis, n. sp.

Pertenuis, very small.

♀, 6 mm. Head and palpi white. Antennae pale grey becoming whitish towards base. Thorax and abdomen white. Legs white; tarsi with slender fuscous annulations. Forewings white; three pale-fuscous transverse fasciae at $\frac{1}{4}$, middle, and $\frac{3}{4}$, the first two indistinct; an apical black spot; cilia pale fuscous, on costa and dorsum white. Hindwings lanceolate; whitish; cilia 4, whitish.

Queensland: Coolangatta, in October, one specimen.

ACROCERCOPS HETEROPSIS, Low.

Queensland: Charleville, in September. I took three examples of this curiously-marked species on the lee side of a fence after a storm. The thorax is depressed, not raised from the surface in the position of rest. The fuscous colouring of the hindwings is confined to the male; in the female these are grey. This form of sexual difference does not occur in any other species of the genus, so far as I know.

Parectopa actinosema, n. sp.

ἀκτινοσημος, brilliantly marked.

♂, 9 mm. Head silvery-white. Palpi whitish; second joint fuscous externally; terminal joint as long as second. Antennae fuscous; basal joint

with a terminal tuft of long scales anteriorly. Thorax white; patagia fuscous. Abdomen dark grey. Legs fuscous; tarsi broadly annulated with white; middle tibiae strongly expanded at apex. Forewings narrow, costa nearly straight; brownish-fuscous; four snow-white spots edged with fuscous; first on base of dorsum, elongate; second on dorsum from before 1/4 to middle, upper edge curved, reaching more than half across disc; third on dorsum from beyond middle to 5/6, reaching half across disc, upper edge bisinuate; fourth subapical, smaller, oval; cilia grey, on apex ochreous-brown. Hindwings and cilia grey.

Queensland: Coolangatta, in October, one specimen.

Gracilaria pedina, n. sp.

πεδινος, living on the plain.

♂, 12-13 mm. Head and thorax grey. Palpi whitish, apex of second joint and a subapical ring on terminal joint dark fuscous. Antennae grey annulated with fuscous. Legs fuscous irrorated with whitish; posterior pair and middle tarsi mostly whitish. Forewings narrow, posteriorly dilated, costa strongly arched towards apex; grey finely irrorated with dark fuscous; a broadly suffused whitish streak, not clearly defined, on costa from 1/4 to 3/4, containing some dark-fuscous scales, and two dark-fuscous dots in basal part, interrupted almost completely by dark-fuscous scales before middle; cilia grey, around apex mixed with dark fuscous. Hindwings and cilia grey.

Queensland: Charleville, in September, two specimens.

Gracilaria thiophylla, Turn.

I think *G. liparoxantha*, Meyr., Exot. Micro., ii., p. 297 (1920), is a synonym.

Fam. PLUTELLIDAE.

Gen. Leuroptila, nov.

λευροπτιλος, smooth winged.

Head moderately rough haired, with anterior rough hairs on fillet; face smooth. Labial palpi rather long, smooth, drooping; terminal joint shorter than second. Tongue developed. Maxillary palpi very short, porrect. Antennae 4/5; basal joint stout, with strong pecten. Posterior tibiae smooth scaled. Forewings with 2 and 3 connate from angle of cell, 4 absent, 7 to costa, 8 and 10 absent. Hindwings elongate-ovate; 4 absent, 3 and 5 connate, 6 and 7 widely separate, parallel.

Related, I think, though distantly, to *Tonza*, Wlk. In that genus I think vein 7 is present and runs to costa, the absent veins being 5, 8, 9, and 10.

Leuroptila tephropasta, n. sp.

τεφροπαστος, sprinkled with ashes.

♀, 13 mm. Head and palpi ochreous grey-whitish. Antennae grey, towards base paler. Thorax whitish-grey. Abdomen grey. Legs pale grey. Forewings moderate, costa straight to 2/3, thence arched, apex obtuse; ochreous-grey-whitish finely irrorated and transversely strigulated with grey; suffused grey spots on 1/3 dorsum and in disc above tornus; cilia pale ochreous-grey with apical and subapical fuscous lines. Hindwings grey; cilia 1, grey.

Queensland: Toowoomba, in December, one specimen.

Diathryptica callibrya, n. sp.

καλλβρυος, beautifully moss-green.

♂, 14 mm. Head green. Palpi fuscous; inner surface grey-whitish. Antennae fuscous; ventral surface grey-whitish; in male simple. Thorax fuscous. Abdomen grey. Legs fuscous; posterior pair paler; tarsi ringed

with whitish. Forewings rather narrow, costa gently arched, apex pointed, termen straight, oblique; pale grey mottled with fuscous and suffused with green; a broad green dorsal streak, its edge very irregular, obtusely indented at ⅓ and ⅔, containing a basal dorsal fuscous spot; six equidistant quadrangular dark costal spots; centre of disc suffusedly darker; terminal edge irrorated with black and white scales; cilia green, apices paler, a fuscous bar at apex, and another on costa before apex. Hindwings elongate-ovate; grey; cilia ⅔, grey.

This protectively coloured but singularly beautiful moth is difficult to describe; it is, however, unlike anything else.

Queensland: National Park (3,500-4,000 feet), in December, two specimens.

Diathryptica theticopis, n. sp.

θητικωπις, of menial appearance.

♀, 15 mm. Head, palpi, and thorax fuscous. Antennae grey. Abdomen whitish; paired fuscous dots on dorsum of third to sixth segments. Legs fuscous; posterior pair whitish. Forewings rather narrow, costa gently arched, apex rounded, termen obliquely rounded; ochreous-fuscous with moderate dark-fuscous irroration; a dark-fuscous discal dot at ¾; cilia fuscous. Hindwings elongate-ovate; 3 and 4 stalked; whitish; cilia ½, whitish.

Queensland: Brisbane, in April, one specimen.

Orthenches liparochroa, n. sp.

λιπαροχροος, glossy.

♂, 17 mm. Head, palpi, and thorax fuscous Antennae grey, towards base fuscous. Abdomen and hindlegs whitish. Forewings moderate, costa rather strongly arched, apex rounded, termen obliquely rounded; very pale ochreous with general fuscous irroration and markings, rather glossy; an ill-defined, rather broad, antemedian, transverse fascia; four fairly equidistant costal spots between this and apex; where fuscous irroration is less dense it forms small transverse strigulae; cilia whitish-ochreous with a fuscous sub-basal line. Hindwings broadly ovate; grey-whitish; cilia ¼, grey-whitish.

Queensland: Killarney, in October, one specimen.

Orthenches pleurosticta, n. sp.

πλευροστικτος, with spotted costa.

♂, 15 mm. Head fuscous; face ochreous-whitish. Palpi fuscous; inner surface ochreous-whitish. Antennae fuscous; pecten ochreous-whitish. Thorax fuscous. Abdomen grey. Legs whitish; anterior pair fuscous; all tarsi fuscous with two whitish rings. Forewings rather narrow, costa gently arched, apex nearly rectangular, termen obliquely rounded; whitish irrorated and marked with fuscous-grey; a clearly defined basal patch, its edge running from ¼ costa to ⅓ dorsum; costa with numerous minute strigulae; a large triangular discal spot above tornus, and another between this and termen; cilia fuscous, apices whitish except on tornus and dorsum. Hindwings elongate-ovate; grey; cilia ½, grey.

Queensland: Toowoomba, in October, one specimen.

Paraphyllis pamphaea, n. sp.

παμφαιος, all dusky.

♂, ♀, 18-24 mm. Head, thorax, and abdomen fuscous. Palpi whitish. Antennae fuscous. Legs fuscous; posterior pair grey. Forewings with costa moderately arched, apex pointed; fuscous; cilia fuscous. Hindwings broadly lanceolate; fuscous; cilia fuscous.

Queensland: Brisbane, in February; Victoria: Gisborne, in September; three specimens.

Paraphyllis diatoma, n. sp.

διατομος, divided throughout.

♀, 24 mm. Head, antennae, thorax, and abdomen fuscous. Palpi whitish. Legs fuscous; posterior pair grey. Forewings with costa strongly arched, apex pointed; fuscous; a broad whitish line slightly above middle from base to apex; cilia fuscous, on apex whitish. Hindwings broadly lanceolate, fuscous; cilia fuscous.

New South Wales: Sydney, one specimen.

Paraphyllis stichogramma, n. sp.

στιχογραμμος, marked with lines.

♂, 20 mm. Head and thorax fuscous. Palpi whitish; extreme apex fuscous. Antennae grey. Abdomen grey. Legs grey [posterior pair broken off]. Forewings elongate-oval, costa gently arched, termen very oblique, tornus not defined; a well-marked but ill-defined white streak from middle of disc to termen; an obscure suffused white dorsal streak, not reaching base; cilia fuscous, on dorsum grey. Hindwings broadly lanceolate; grey; cilia 1½, grey.

Queensland: Brisbane, in December, one specimen.

Paraphyllis ochrocera, n. sp.

ὠχροκερος, with pale antennae.

♂, 18 mm. Head whitish. Palpi grey; internal surface whitish. Antennae whitish; apical half grey. Thorax fuscous; anterior edge whitish. Abdomen ochreous-grey. Legs grey; anterior pair fuscous; hairs on posterior tibiae ochreous tinged. Forewings elongate-oval, costa strongly arched, apex pointed, termen very oblique; fuscous; a narrow whitish streak on basal half of costa; a similar median streak from base throughout, broadening just before termen; a third streak on posterior half of fold; cilia fuscous. Hindwings broadly lanceolate; grey; cilia 1, grey.

A true *Paraphyllis*, but differs from other species in 7 and 8 of forewings being separate at origin

Northern Territory: Darwin, one specimen received from Mr. G. F. Hill.

Fam. COPROMORPHIDAE.

HYPERTROPHA TORTRICIFORMIS, Gn.

North Queensland: Claudie River, in December, one specimen, differing from the typical form in having the hindwings fuscous, except for a rather small orange median spot. This may represent a local race or subspecies.

Fam. AMPHITHERIDAE.

AMPHITHERA HETEROLEUCA, Turn.

Having obtained a series of this species from the National Park, Queensland, I am satisfied that *A. monstruosa*, Turn., is the same species. It differs only in the less development of white apices to the forewings, and this differs in individual specimens.

North Queensland: Herberton; Queensland: Nambour, Brisbane, Coolangatta, National Park (3-4,000 feet); New South Wales: Ebor, Katoomba.

Amphithera hemerina, n. sp.

ἡμερινα, diurnal.

♂, 18 mm. Eyes much enlarged ventrally, sharply incised posteriorly, so as to partially separate a smaller dorsal portion. Head and palpi brassy-yellow. Antennae longer than forewings [tips broken off], simple; brassy-yellow annulated with fuscous. Thorax fuscous with large anterior and smaller posterior brassy-yellow spots. Abdomen fuscous; beneath pale ochreous; apical third shining white. Legs pale ochreous. Forewings elongate, costa straight to $\frac{2}{3}$, thence strongly arched, apex pointed, termen very oblique; fuscous; markings brassy-yellow, their edges rather suffused; a basal fascia; a suffused patch on $\frac{2}{3}$ costa, which gives off two clear processes; first inwards to middorsum, gradually broadening towards dorsum; second outwards to below middle of termen; an apical spot, its outer edge defined by a blackish line; cilia fuscous barred with yellow at apex and opposite terminal process. Hindwings with 4 absent; fuscous; cilia fuscous.

Notwithstanding the absence of vein 4 in the hindwings this species is allied to *A. heteroleuca*, and the ocular structure in the male shows the first stage in the development of the extraordinary eyes in the male of that species.

Queensland: National Park (3,000 feet), in January, one specimen.

Fam. LYONETIADAE.

Phyllocnistis eurymochla, n. sp.

εὐρομοχλος, broadly barred.

♂, 5 mm. Head, thorax, palpi, and antennae whitish. Abdomen grey-whitish. Legs whitish. Forewings moderate, apex rather obtusely pointed and deflexed; white; a broad fuscous longitudinal bar beneath middle third of costa, extending from immediately beneath costa to fold, giving off a slender line beneath costa towards base, receding from costa posteriorly, and ending in an obtusely rounded point, where it is joined by a fine fuscous line from $\frac{2}{3}$ costa; beyond this a fine transverse fuscous line; beyond this again a large pale-orange spot, limited posteriorly by a fine fuscous line, which bifurcates before running to costa; a black apical dot; cilia whitish. Hindwings almost linear; whitish; cilia over 12, whitish.

North Queensland: Kuranda in October, Herberton in June, two specimens, of which one is in Coll. Meyrick.

Phyllocnistis diplomochla, n. sp.

διπλομοχλος, doubly barred.

♂, ♀, 5 mm. Head, palpi, and thorax white. Antennae white, becoming grey towards apex. Abdomen grey. Legs whitish. Forewings moderate, apex obtuse, with a very small deflexed terminal process; white; two longitudinal fuscous lines from base to $\frac{2}{3}$, first from base of costa, soon becoming subcostal, second median, area between them ochreous tinged; a short, outwardly oblique, fuscous streak from costa beyond middle; beyond this a fine fuscous transverse line; a black apical dot; cilia white with two costal bars and a subapical hook fuscous. Hindwings almost linear; whitish; cilia over 12, whitish.

Near *P. atractias*, Meyr., but without triangular dorsal spot.

Queensland: Brisbane, three specimens.

Phyllocnistis leptomianta, n. sp.

λεπτομιαντος, slightly stained.

♀, 5 mm. Head and thorax yellowish-white. Palpi whitish. Antennae whitish, towards apex tinged with grey. Abdomen and legs whitish. Forewings

moderate, apex acute; yellowish-white; short oblique fuscous streaks from costa at ⅓ and middle directed outwards; a similar streak from dorsum before tornus; cilia whitish with four fine fuscous streaks on costal portion, first two outwardly oblique, last two more transverse, and a short dorsal streak near apex. Hindwings linear-lanceolate; whitish; cilia over 12, whitish.

Distinguished by the yellow-tinged forewings without longitudinal streaks and apical dot.

Queensland: Brisbane, in August, one specimen.

Crobylophora psammosticta, n. sp.

ψαμμόστικτος, sandy spotted.

♂, 6-7 mm. Head, palpi, antennae, thorax, abdomen, and legs white. Forewings white; markings pale brownish-ochreous partly outlined with fuscous scales; a median basal spot, nearly confluent with a larger spot on fold; a third spot touching fold and middorsum, its long axis inwardly-oblique; two outwardly-oblique streaks from costa at ⅓ and ⅔; a subapical costal dot; a raised silvery spot on tornus; cilia white. Hindwings narrow-lanceolate; white; cilia white.

Queensland: Caloundra and Brisbane, in August, two specimens.

Leucoptera argodes, n. sp.

ἀργώδης, white.

♂, 6-8 mm. Head and thorax white; crown smooth. Antennae whitish or pale grey; basal joint white. Abdomen pale grey or grey-whitish. Legs white. Forewings shining white; sometimes two fine outwardly-oblique lines from costa at ¾ and shortly before apex extending half across disc, but these may be very faint; a raised silvery spot at tornus, preceded and followed by a fuscous dot; cilia white, sometimes with a fine fuscous median line opposite apex. Hindwings narrow-lanceolate; white; cilia white.

Very similar to *L. daricella*, Meyr., which I refer to the same genus; it may be distinguished by the first costal line being far beyond middle, and by the smooth crown.

North Queensland: Kuranda; Queensland: Brisbane, in August and September; five specimens.

Leucoptera strophidota, n. sp.

στροφιδοτος, girdled.

♀, 6 mm. Head white; frons prominent with a small crest of scales on crown. Antennae grey; basal joint white. Thorax white. Abdomen grey-whitish Legs white; anterior tarsi grey. Forewings shining white; a broad brassy transverse fascia at about ⅓, fuscous in certain lights, dilated on dorsum, where it reaches middle; a large brassy apical spot; cilia white, with a fine fuscous apical hook. Hindwings almost linear; pale grey; cilia grey-whitish.

Though very distinctly marked, this and the following resemble *L. daricella* in the tufted head.

North Queensland: Kuranda, near Cairns, in October and November, three specimens received from Mr. F. P. Dodd.

Leucoptera plagiomitra, n. sp.

πλαγιομιτρος, obliquely girdled.

♂, ♀, 7-9 mm. Head and thorax white; crown with a crest of rough hairs. Antennae grey-whitish; basal joint white. Abdomen pale grey or whitish. Legs white; tarsi annulated with fuscous. Forewings shining white; a moderate, inwardly-oblique, brassy fascia from ⅓ costa to near base of dorsum, somewhat

dilated on dorsum; a large brassy tornal spot; a short, outwardly-oblique, fuscous streak from ⅗ costa; a similar but broader streak at apex; cilia white, on costa and a fine apical hook fuscous. Hindwings narrow-lanceolate; white; cilia white.

Queensland: Brisbane, in September; Toowoomba, in September and October; Bunya Mountains (3,500 feet), in October; six specimens.

Leucoptera chalcopleura, n. sp.

χαλχοπλευρος, with sides of brass.

♀, 6 mm. Head and thorax white; crown smooth. Antennae grey; basal joint white. Abdomen and legs white. Forewings shining white; an outwardly-oblique, suboblong, coppery-fuscous spot on costa at ⅓; two short converging lines from costa beyond ⅗, with intervening irroration, fuscous; a large silvery tornal spot narrowly edged anteriorly and posteriorly with blackish; cilia white, on tornus fuscous tinged, with two fine fuscous lines from costa. Hindwings narrow-lanceolate; white; cilia white.

Queensland: Brisbane, in October, one specimen.

Leucoptera melanolitha, n. sp.

μελανολιθος, black jewelled.

♀, 5 mm. Head and thorax snow-white; crown smooth. Antennae whitish-grey; basal joint white. Abdomen pale grey. Legs whitish. Forewings snow-white; a large, quadrangular, blackish spot on ⅛ costa, reaching fold; two fine, parallel, outwardly-oblique, fuscous streaks from costa at ¾ and before apex; a large, quadrangular, silvery, tornal spot, edged anteriorly and posteriorly with blackish; cilia white with a short, oblique, fuscous streak above apex, and two blackish dots, longitudinally placed beneath apex. Hindwings and cilia whitish.

Resembles *L. chalcopleura*, but the costal spot is black and not oblique, the costal streaks are not converging, and the cilia are different.

Queensland: National Park (3,000 ft.), in January, one specimen.

Leucoptera argyroptera, n. sp.

ἀργυροπτερος, silvery winged.

♀, 5 mm. Head white; crown smooth, silvery-grey. Antennae grey; basal joint white. Thorax silvery-grey. Abdomen grey. Legs whitish. Forewings silvery-grey; an outwardly-oblique, ochreous streak, edged with fuscous from midcosta, and a similar streak from middorsum, the two meeting at an acute angle; an ochreous spot on costa at ¾; a narrow subterminal ochreous fascia, preceded by a blackish dot on dorsum, and followed by a blackish spot in disc; a large grey spot slightly above tornus; cilia whitish, an outwardly-oblique fuscous line from costa, nearly meeting another from apex in a wide V. Hindwings narrow-lanceolate; whitish-grey; cilia whitish-grey.

North Queensland: Bowen, in June, one specimen.

Leucoptera iolitha, n. sp.

ἰολιθος, with violet jewel.

♀, 6 mm. Head and thorax white. Antennae fuscous; basal joint white. Abdomen grey. Legs white; tarsi partly fuscous. Forewings shining white; a fine, fuscous, outwardly-oblique line from midcosta, meeting a curved line from ¾ dorsum; beyond these the disc is wholly brownish-ochreous, except for three white costal spots, a metallic tornal spot with violet reflections, and a

black subapical spot; cilia grey, on costa whitish with two fuscous streaks, one nearly transverse almost meeting another internally oblique from apex. Hindwings narrow-lanceolate; grey; cilia grey.

Queensland: Mount Tambourine, in October, one specimen.

Leucoptera diasticha, n. sp.

διαστιχος, through lined.

♀, 5 mm. Head and thorax white; crown smooth. Antennae grey; basal joint white. Abdomen grey. Legs whitish. Forewings white; a fine fuscous line from ⅗ costa to dorsum before tornus, followed by a pale-ochreous shade, which is limited by a second shorter parallel line reaching middle of disc; a third subapical line reaching as far; a silvery tornal spot, preceded and followed by a black dot; cilia white, with three diverging lines in costa, the third running to apex. Hindwings narrow-lanceolate; pale grey; cilia pale grey.

Recognizable by the through line from costa to dorsum.

New South Wales: Hornsby, in June, one specimen received from Dr. R. J. Tillyard.

Leucoptera toxeres, n. sp.

τοξηρης, bearing a bow.

♂, ♀, 4-5 mm. Head and thorax white; crown smooth. Antennae grey; basal joint white. Abdomen grey. Legs white. Forewings white; a fine, fuscous, outwardly-oblique line from costa before middle to middisc, a second parallel line just beyond middle, the included area pale-ochreous; a slightly outwardly-curved fuscous line from ¾ costa to dorsum before tornus; a short subapical line from costa; a pale-ochreous tornal blotch edged on termen by a dark-fuscous line; a black apical spot; cilia whitish. Hindwings narrow-lanceolate; grey-whitish; cilia whitish.

Recognizable by the curved, transverse, postmedian line.

North Queensland: Kuranda, in June; Queensland: Dulong, near Nambour, in April; two specimens.

Leucoptera asbolopasta, n. sp.

ἀσβολοπαστος, sprinkled with soot.

♂, 6 mm. Head and thorax white; crown smooth. Antennae grey; basal joint white Abdomen pale grey with a large, subbasal, blackish, dorsal spot; tuft and underside whitish. Legs white. Forewings shining white; very faintly marked with ochreous; a costal spot beyond middle, two short lines from costa between this and apex, and a short erect mark from tornus; cilia white, two fine fuscous lines from costa, the second of these is prolonged in a sinuous fashion around apex and becomes blackish as far as tornus, limiting an ochreous-tinged basal area. Hindwings narrow-lanceolate; grey-whitish densely irrorated with blackish scales except at apex; cilia whitish. Underside of both wings with greater part of disc densely irrorated with blackish scales.

Very similar to *L. periphracta*, Meyr., of which I have both sexes from the same locality, readily distinguished by the peculiar blackish irroration, which may be sexual.

North Queensland: Kuranda, one specimen received from Mr. F. P. Dodd.

Opostega chalcoplethes, n. sp.

χαλκοπληθης, filled with brass.

♂, 14 mm. Head white. Palpi grey. Antennae grey; basal joint white. Thorax brassy-fuscous. Abdomen grey. Legs grey-whitish; anterior pair fuscous. Forewings lanceolate, apex acute; brassy-fuscous; a white costal streak from near base to near apex; a white dorsal streak from near base to

tornus, interrupted in middle; apex blackish; cilia white, on apex broadly blackish. Hindwings lanceolate; pale grey; cilia pale grey.

Western Australia: Perth, one specimen.

Opostega brithys, n. sp.

βριθυς, heavy.

♀, 16 mm. Head, palpi, antennae, and thorax white. Abdomen grey. Legs ochreous-whitish; anterior pair greyish. Forewings white, slightly greyish tinged, becoming grey near apex; cilia grey, basal half fuscous around apex, on tornus and dorsum wholly whitish. Hindwings broadly lanceolate; grey; cilia grey.

A remarkably large species for this genus.

North Queensland: Cairns district, one specimen received from Mr. F. P. Dodd.

Opostega monotypa, n. sp.

μονοτυπος, with one mark.

♂, 8 mm. Head, palpi, antennae, and thorax white. Abdomen and legs whitish. Forewings white; a suboval, fuscous, costal spot slightly beyond middle; a minute apical black dot; cilia whitish. Hindwings narrow-lanceolate; grey-whitish; cilia whitish.

North Queensland: Cairns district, one specimen received from Mr. F. P. Dodd.

Opostega atypa, n. sp.

ἀτυπος, without marking.

♀, 8 mm. Head, palpi, antennae, and thorax white. Abdomen and legs ochreous-whitish. Forewings broadly-lanceolate, acute; white, towards dorsum faintly ochreous tinged; cilia whitish. Hindwings lanceolate; grey-whitish; cilia whitish.

North Queensland: Cairns, in July, one specimen.

Opostega phaeospila, n. sp.

φαιοσπιλος, with dusky spot.

♂, 7 mm. Head, palpi, antennae, and thorax white. Abdomen grey. Legs whitish; anterior pair grey. Forewings white; a small fuscous spot on costa at ⅔; two fine, outwardly-oblique, converging, short, fuscous streaks from costa before apex; cilia whitish, a fine, fuscous, transverse streak above apex, and a short, blackish, transverse streak opposite apex. Hindwings and cilia pale grey.

Queensland: National Park (3,500 to 4,000 feet), in January, one specimen.

Opostega centrospila, n. sp.

κεντροσπιλος, with central spot.

♂, 7-8 mm. Head, palpi, and thorax white. Antennae grey, towards base white. Legs grey; posterior pair whitish. Forewings moderate, apex obtuse; white with fuscous markings; an elongate spot in disc above middle; an oblique streak from midcosta and another from dorsum, the two sometimes meeting; a variable marginal suffusion on apex and termen; cilia whitish with some fuscous admixture, on dorsum grey-whitish. Hindwings lanceolate; pale grey; cilia 4, pale grey.

Queensland: Brisbane, in August; Mount Tambourine, in November; two specimens.

Opostega phaeopasta, n. sp.

φαιοπαστος, dusky sprinkled.

♀, 6 mm. Head, thorax, and palpi white. Antennae grey, towards base white. Abdomen pale grey. Legs whitish. Forewings moderate, obtuse, but with a short, narrow-pointed, apical process; white; a broadly suffused band of fuscous irroration from dorsum near base, towards and connected with costa at ⅓, thence subcostal to near apex; a fuscous dot on termen; cilia whitish, beneath apical process fuscous. Hindwings lanceolate; whitish; cilia 6, whitish.

Queensland: Coolangatta, in September, one specimen.

Bucculatrix ulocarena, n. sp.

οὐλοκαρηνος, shaggy headed.

♀, 6-7 mm. Head with a dense tuft of hairs on crown; whitish. Antennae grey; basal joint whitish, dilated into an eyecap, which is pectinate on anterior edge. Thorax grey-whitish. Abdomen grey. Legs grey. Forewings moderate, apex acute; grey-whitish, posterior half more or less irrorated with dark fuscous; cilia grey, on apex and termen irrorated with dark fuscous. Hindwings lanceolate; grey; cilia 5, grey.

Queensland: Brisbane, in November, January, February, and March, four specimens.

Hierocrobyla lophocera, n. sp.

λοφοκερος, with crested antennae.

♂, 9 mm. Head whitish; crown smooth, a small crest of rough hairs on fillet. Antennae grey; basal joint whitish, elongate, dilated into an eyecap from the distal end of which projects a strong pointed process, nearly as long as itself. Thorax whitish-ochreous. [Abdomen broken off.] Legs whitish. Forewings narrow, apex pointed; whitish-ochreous; cilia ochreous-whitish, on dorsum grey-whitish. Hindwings lanceolate; grey-whitish; cilia 6, grey-whitish.

Like *H. sporodectis*, Meyr., but with peculiar antennal structure.

Queensland: National Park (3,000 feet)), in December, one specimen.

Lyonetia embolotypa, n. sp.

ἐμβολοτυπος, wedge marked.

♂, 8 mm. Head and palpi white. Antennae whitish, towards apex grey; basal joint white. Thorax whitish. [Abdomen broken.] Legs whitish; posterior tibiae and first two tarsal joints with apical dark-fuscous dots. Forewings whitish; markings brownish-fuscous; a dorsal spot near base; a broad oblique streak from ½ dorsum meeting another from ⅓ costa at an acute angle in middisc; a second oblique costal streak from beyond middle, nearly meeting a tornal spot; a third short costal streak at ⅘, and another between this and apex; a black dot at apex; cilia grey, on costa and apex whitish with two costal and one apical brownish-fuscous bars. Hindwings almost linear; grey; cilia grey.

Nearest *L. leptomitella*, Meyr.; *Stegommata*, Meyr., is, I think, another name for *Lyonetia*.

Queensland: Mount Tambourine, in November, one specimen.

Lyonetia acromelas, n. sp.

ἀκρομελας, black at the apex.

♂, 8 mm. Head, thorax, and palpi white. Antennae 1½, basal joint dilated to form a broad eyecap; white, becoming grey towards apex. [Abdomen broken off.] Legs white; middle tarsi with blackish dots on dorsum [posterior pair broken off]. Forewings narrow, apex with a short, slender, acute, deflexed, terminal process; white; a very slender fuscous streak from ¼ dorsum to middle of disc, strongly outwardly-oblique; similar streaks from ⅗ costa and

tornus meeting in an acute angle at middisc; a slender transverse outwardly-curved line beyond this; an intensely black subapical spot; cilia whitish. Hindwings linear-lanceolate; whitish; cilia 10, whitish, a fuscous apical dot.

In this and the following the crown of head is smooth, except for a few raised scales on fillet between antennae.

North Queensland: Kuranda, in July, one specimen.

Lyonetia photina, n. sp.

φωτεινος, lustrous.

♂, 11-12 mm. Head vertically compressed, smooth, fillet projecting anteriorly, with a few rough scales on edge; brownish with green-brassy reflections; face white. Palpi white. Antennae over 1½, broadly dilated at base to form a large eyecap; grey. Thorax brown with metallic lustre. Abdomen grey; beneath white. Legs white; posterior tarsi with four blackish dots on dorsum. Forewings narrow, apex bent dorsad in a twisted acuminate process; green-brassy and lustrous; three large, longitudinally oval spots resting on costa, where they are fuscous, becoming greenish-metallic in disc, the first two extending to dorsum; in certain lights costal part of disc between these spots is tinged with reddish-violet; cilia beneath apical process grey. Hindwings linear-lanceolate; grey; cilia 10, grey.

It is impossible to give an adequate verbal description of the ever-changing, flashing lustre of this brilliant insect.

North Queensland: Kuranda, three specimens received from Mr. F. P. Dodd.

Gen. **Coeliometopa**, nov.

κοιλιομετωπος, with hollowed front.

Head smooth on crown with a fringe of anteriorly projecting rough scales on fillet; face smooth, retreating, excavated so as to form a deep concavity. Labial palpi moderately long, slender, smooth, drooping. Maxillary palpi long, folded. Antennae ⅘; basal joint stout without pecten. Posterior tibiae clothed with long hairs. Forewings with 4 absent, 7 and 8 stalked out of six, 7 to termen, 11 from somewhat beyond middle. Hindwings with all veins present, 6 and 7 stalked.

Coeliometopa hypolampes, n. sp.

ὑπολαμπης, somewhat shining.

♀, 12 mm. Head fuscous; face and palpi ochreous-whitish. Antennae fuscous. Thorax and abdomen fuscous. Legs fuscous on dorsal, grey on ventral surfaces. Forewings narrow-oblong, apex rounded; brownish-fuscous; a grey-whitish median suffusion based on costa and reaching fold; a broad grey-whitish line from costa before apex to termen; a grey-whitish terminal line from tornus to middle; a blackish median streak from above tornus to apex, interrupted on subapical whitish line; cilia grey, on apex brown with a fine, short, blackish hook. Hindwings lanceolate; grey with a coppery sheen; cilia 3, grey.

Queensland: National Park (3,000 feet), in January, one specimen.

Opogona tristicta, Meyr.

I suspect *O. calculata*, Meyr. (Exot. Micro., ii., p. 287), is a synonym of this. The number of black dots on forewing is variable.

North Queensland: Herberton; Queensland: Duaringa, Nambour, Brisbane.

Opogona protodoxa, Meyr.

The colour of the head appears to be variable. I have received two examples, which I cannot distinguish from this species, from Gisborne, with the head yellow.

OPOGONA BASILISSA, Turn.

Best distinguished from *O. protodoxa* by the shape of the basal costal streak. In *basilissa* it is broadest at or beyond its middle, in *protodoxa* broadest at its base.

Queensland: Mount Tambourine, National Park (2,500 to 3,000 feet).

OPOGONA ORTHOTIS, Meyr.

This species is also variable. The thorax may be wholly yellow and the basal costal streak of forewings absent; intermediate examples between this and the typical form occur.

North Queensland: Cairns, Innisfail; Queensland: Nambour, Brisbane; Western Australia: Carnarvon.

Opogona papayae, n. sp.

♂, 12 mm. Head fuscous; fillet and face glossy grey-whitish. Labial palpi fuscous, internal surface whitish. Antennae pale ochreous; basal joint fuscous. Thorax and abdomen fuscous, the latter whitish beneath. Legs pale fuscous. Forewings yellow; base of costa fuscous; a fine, blackish, irregular, transverse line from $\frac{3}{5}$ costa to $\frac{3}{5}$ dorsum; immediately beyond this is a metallic line with bluish and purple reflections; disc posterior to this brownish-fuscous, with a few metallic scales, and a yellow, costal, subapical spot; cilia brownish. Hindwings lanceolate; brownish; cilia brownish.

Northern Territory: Darwin, in August, one specimen received from Mr. G. F. Hill with the note, "From Papaw stem, pupated 17-7-4, emerged 4-8-14."

Opogona crypsipyra, n. sp.

κρυψιπυρος, with hidden fire.

♀, 12 mm. Head, crown, and fillet fuscous; face whitish. Labial palpi fuscous. Antennae pale ochreous; basal joint fuscous. Thorax pale yellow, anterior margin broadly fuscous. Abdomen brownish-grey. Legs ochreous-whitish; anterior pair fuscous. Forewings pale yellow; a broad streak on basal $\frac{1}{5}$ of costa, terminating abruptly; apical area brownish-fuscous beyond an irregularly dentate, fine, blackish line from beyond midcosta to before tornus; the edge and part of the centre of this area shows brassy and violet reflections in oblique illumination; cilia brownish. Hindwings lanceolate; grey; cilia grey.

Northern Territory: Darwin, one specimen from Mr. G. F. Hill with the note, "Destroys bark of Papaw plants."

Opogona flabilis, n. sp.

flabilis, airy.

♂, ♀, 8-9 mm. Head and thorax whitish-brown; face whitish. Palpi whitish, second joint with an apical fuscous dot on external surface. Antennae whitish-brown with two fuscous rings near base. Abdomen grey. Legs whitish; anterior pair brownish tinged. Forewings rather narrow, costa gently arched; whitish-brown sparsely irrorated with fuscous-brown, more so towards base, middle of costa, and apex; cilia whitish-brown. Hindwings lanceolate; grey; cilia grey.

North Queensland: Atherton, in June, two specimens.

Gen. **Pycnobela**, nov.

πυκνοβελος, with thick weapons (palpi).

Head and face smooth with raised rounded fillet between antennae. Labial palpi long, recurved, diverging; terminal joint dilated, obtuse, laterally

compressed. Maxillary palpi rudimentary. Antennae with basal joint long, flattened, concave beneath. Forewings with 2 from near angle, one vein absent (I am not sure which), remaining veins all separate. Hindwings with one vein absent, remaining veins all separate.

Doubtless allied to *Opogona,* with which it agrees in the structure of head and antennae, though palpi and neuration are very different.

Pycnobela aplectodes, n. sp.

ἀπλεκτωδης, simple.

♂, ♀, 12-15 mm. Head dark grey; face white. Palpi whitish, apices of second and terminal joints grey on upper-surface. Antennae fuscous annulated with white. Thorax dark grey, anterior edge narrowly white. Abdomen grey; tuft ochreous-whitish; underside whitish. Legs grey; posterior pair whitish. Forewings elongate-oval, apex pointed; dark-grey; a white costal streak from base to apex, where it is slightly dilated, and contains four fuscous dots, three costal and one terminal; cilia grey, on apex and costa white. Hindwings very broadly lanceolate; grey; cilia grey.

North Queensland: Kuranda, in September and October, four specimens received from Mr. F. P. Dodd.

Comodica eurynipha, n. sp.

εὐρυνιφος, broadly snow-white.

♀, 16 mm. Head white; sides of crown and face blackish. Palpi fuscous; inner-surface white. Antennae fuscous. Thorax fuscous, with a large central white spot extending to anterior margin. Abdomen grey. Legs whitish; anterior pair fuscous. Forewings moderate, apex obtuse; fuscous, towards apex brownish tinged, markings white; a broad basal costal streak, extending to $\frac{1}{3}$ costa, then narrowing to a point at about middle of disc; two oblique streaks from costa at middle and $\frac{2}{3}$, the latter slender; an elongate mark on tornus; a fine fuscous line from $\frac{3}{4}$ costa, rather sharply bent before apex, ending on edge of tornal mark; an apical blackish dot in a grey suffusion; cilia whitish with a median line and a dot opposite apex dark fuscous. Hindwings ovate-lanceolate; grey; cilia $\frac{2}{3}$, grey.

Nearest *C. acontistes,* Meyr.

Queensland: National Park (3,000 feet), in December, one specimen.

Comodica crypsicroca, n. sp.

κρυψικροκος, with hidden saffron.

♂, 9 mm. Head grey-whitish. Palpi whitish. Antennae whitish; towards apex grey. Thorax and abdomen grey. Legs dark fuscous annulated with white; posterior pair whitish. Forewings moderate, obtuse, but with slight apical projection; white with some fuscous suffusion on basal and dorsal areas; a short fuscous streak from base on fold; costal edge fuscous with three broad-based costal streaks, at base, $\frac{1}{3}$, and just beyond middle, the last longer and extending obliquely outwards to middle of disc; a narrow white streak separates this from an orange-brown, oblique, fuscous-edged, subapical streak; an orange-brown spot on termen edged posteriorly with blackish; cilia pale ochreous with two costal and one subapical blackish bars. Hindwings ovate-lanceolate; pale grey; cilia 1, pale grey.

New South Wales: Lismore, in October, two specimens.

Comodica drepanosema, n. sp.

δρεπανοσημος, sickle marked.

♀, 9 mm. Head, palpi, and thorax grey-whitish. Antennae and abdomen grey. Legs whitish; anterior pair fuscous. Forewings rather narrow, apex

obtuse, termen strongly indented; white with fuscous markings; a costal streak from base to beyond middle with slight posterior projection in disc; two short oblique costal streaks beyond this; a broad-based sickle-shaped streak from dorsum before middle ending in a fine point posteriorly; a leaden-metallic terminal spot preceded by a blackish dot; cilia white with three fine costal bars and a basal spot on apex blackish. Hindwings ovate-lanceolate; grey; cilia 1, grey.

Queensland: Mount Tambourine, in November, one specimen.

Erechthias acroleuca, n. sp.

ἀκρολευκος, white at the apex.

♂, 13 mm. Head and palpi whitish. Antennae ochreous with two fuscous rings before apex; basal joint whitish. Thorax whitish. Abdomen dark grey, beneath ochreous. Legs ochreous mixed with fuscous. Forewings with costa nearly straight, but arched before apex; apex round-pointed; termen very oblique; whitish, but mostly occupied by broad orange-ochreous markings; a basal patch; outwardly-oblique streaks from costa and dorsum at $\frac{1}{4}$, meeting in middle at an acute angle; similar streaks from middle of costa and dorsum; a large apical patch nearly confluent with a large tornal spot; a small snow-white apical spot; cilia orange-ochreous. Hindwings and cilia fuscous.

Queensland: Charleville, in September; I took one example of this fine species on a fence after a storm.

Erechthias polyplecta, n. sp.

πολυπλεκτος, closely twined.

♂, ♀, 9-11 mm. Head, palpi, antennae, and thorax grey-whitish. Abdomen grey. Legs whitish; tibiae and tarsi annulated with fuscous. Forewings rather narrow, apex pointed; whitish with dark-fuscous markings; four outwardly-oblique costal streaks reaching about half across wing; first basal, much expanded on costa, second median, third from $\frac{3}{4}$, fourth subapical; a subbasal dorsal spot, and another at $\frac{1}{2}$; an irregular dentate line from dorsum beyond middle to apices of second and third costal streaks; an apical spot and terminal line; cilia whitish, apices narrowly fuscous except on tornus. Hindwings broadly lanceolate; pale grey; cilia pale grey.

North Queensland: Townsville, in August and September, three specimens.

Erechthias mesosticha, n. sp.

μεσοστιχος, with median streak.

♀, 8-9 mm. Head and thorax brownish-ochreous; face and palpi whitish-ochreous. Antennae whitish-ochreous annulated with dark fuscous. Abdomen grey. Legs ochreous-whitish; tibiae and tarsi annulated with dark fuscous; posterior pair grey. Forewings narrow, apex rounded; whitish-ochreous suffused with brownish-ochreous; a fuscous line on costa from $\frac{1}{4}$ to beyond $\frac{3}{4}$, interrupted in middle; a fine fuscous median longitudinal line from middle to termen, its upper edge whitish towards apex; a short marginal fuscous streak at tornus; cilia ochreous, on tornus and dorsum ochreous-whitish. Hindwings lanceolate; grey; cilia grey.

North Queensland: Kuranda, in June; Cardwell, in August; two specimens.

Erechthias epixantha, n. sp.

ἐπιξανθος, tawny.

♂, 6-7 mm. Head and thorax brownish-ochreous; face and palpi whitish-ochreous. Antennae whitish-ochreous annulated with dark fuscous. Abdomen fuscous. Legs ochreous-whitish; tarsi annulated with fuscous; posterior pair

grey. Forewings moderate, apex rounded; dark brownish-ochreous; costal edge fuscous from near base to near apex; a very slender pale line along fold; another from ¼ costa, at first oblique, then longitudinal to above tornus, partly edged with fuscous beneath; a third from middle joining second at its extremity; a large, triangular, subapical, fuscous, costal spot, giving rise to a sharply angulated subterminal line, edged posteriorly with whitish; cilia ochreous with a fuscous basal line. Hindwings and cilia fuscous.

North Queensland: Innisfail, in November; Queensland: Eumundi, near Nambour, in March; two specimens.

Erechthias cirrhopolia, n. sp.

κιρρόπολιος, yellowish-grey.

♂, ♀, 9-10 mm. Head, palpi, antennae, and thorax whitish-ochreous. Abdomen grey, beneath whitish-ochreous. Legs whitish-ochreous. Forewings elongate-oval, apex pointed; leaden-grey; a pale-ochreous median line from base to a large pale-ochreous terminal suffusion; a whitish costal streak from base, broadly expanded from ⅓ to ⅔, where it ends abruptly; two broad, oblique, wedge-shaped, fuscous, costal streaks crossing white area, and prolonged by pale-ochreous lines into terminal suffusion; a suffused whitish spot on ⅓ dorsum; a blackish dot above tornus, another near termen below middle, and a third at apex; cilia pale ochreous, apices pale grey. Hindwings broadly lanceolate; pale grey; cilia 1½, pale grey.

Queensland: Coolangatta, in September, two specimens.

Erechthias celetica, n. sp.

κηλητικος, charming.

♂, 10 mm. Head and thorax grey; face and palpi dark fuscous. Antennae fuscous. Abdomen grey. Legs whitish; tarsi and middle tibiae annulated with dark fuscous, anterior pair mostly dark fuscous. Forewings dark fuscous; dorsal area broadly but irregularly whitish-grey; a short outwardly-oblique white streak from ¼ costa, running into a white spot at ⅓ above fold; a dark-fuscous spot beneath fold at about ⅓; a second, short, white, oblique, costal streak at middle; a longer, very fine, white streak from ¾ costa, very oblique and nearly reaching termen; a triangular, whitish, subapical, costal spot; an irregular, longitudinal, white, supratornal blotch; termen narrowly whitish; cilia whitish with apical hook and two terminal lines fuscous. Hindwings broadly lanceolate; grey; cilia grey.

Allied to the preceding but with many differences in the markings of forewings.

Queensland: Burpengary, near Brisbane, in December, one specimen.

Erechthias polionota, n. sp.

πολιονωτος, grey backed.

♂, 10 mm. Head and thorax grey; face and palpi dark fuscous. Antennae grey, darker towards apex. Abdomen pale grey. Legs whitish; tarsi and middle tibiae annulated with fuscous; anterior pair wholly fuscous. Forewings dark fuscous; dorsal area broadly grey; three outwardly-oblique white streaks from costa to middle of disc, from costa at ¼, middle, and ¾; a triangular white subapical costal spot; a larger subapical white terminal spot; cilia grey, with subbasal and subapical terminal lines, and costal hook at apex fuscous. Hindwings broadly lanceolate; pale grey; cilia pale grey.

Queensland: Stradbroke Island, in November, one specimen.

Erechthias caustophara, n. sp.

καυστοφαρος, with scorched robe.

♂, ♀, 10-11 mm. Head brown-whitish; face and palpi fuscous. Antennae brown-whitish. Thorax brown-whitish. Abdomen pale grey, brownish tinged. Legs whitish; anterior and middle tibiae, and all tarsi annulated with fuscous. Forewings rather narrow, costa moderately arched; brown-whitish; markings fuscous; a large subbasal costal spot, a second on middle of costa, and a third at $\frac{3}{4}$; a fine outwardly-oblique streak immediately beyond third spot, but separated from it except at extremity; an apical spot; basal and median dorsal dots; a fine subterminal line; cilia brown-whitish, a fine subapical line around apex. Hindwings broadly lanceolate; grey; cilia grey.

North Queensland: Kuranda, in October; Townsville, in September; Queensland: Brisbane, in November and April; six specimens.

Hieroxestis leucoprosopa, n. sp.

λευκοπροσωπος, white faced.

♂, 9-10 mm. Head fuscous-brown; fillet, face, and palpi snow-white. Antennae pale grey; towards base white. Thorax fuscous-brown. Abdomen grey. Legs ochreous-whitish; anterior pair fuscous. Forewings narrow, costa nearly straight, apex rounded; glossy brownish-grey; costal edge whitish; cilia brownish-grey. Hindwings and cilia grey.

Queensland: Mount Tambourine, in October and November, three specimens.

Fam. TINEIDAE.

Acridotarsa deloneura, n. sp.

δηλονευρος, with conspicuous nerves.

♂, 27 mm. Head and thorax whitish-ochreous. Palpi very long, apical joint depressed; whitish-ochreous. Antennae with basal pecten, apices of joints dilated; whitish-ochreous. Abdomen whitish-ochreous. Legs whitish-ochreous; anterior and middle pair suffused with fuscous anteriorly; middle and posterior tarsi much longer than tibiae. Forewings elongate, costa gently arched, apex acute, termen very oblique; all veins separate; whitish-ochreous; veins irrorated with brownish-fuscous; cilia whitish-ochreous with a few basal fuscous points. Hindwings broader than forewings; all veins separate; ochreous-whitish; cilia ochreous-whitish.

Western Australia: Busselton, one specimen.

Gen. **Palaeoneura**, nov.

παλαιονευρος, with primitive neuration.

Head and face rough haired. Labial palpi moderately long, porrect; second joint with long loose hairs; terminal joint much shorter than second, pointed. Maxillary palpi and tongue obsolete. Antennae about $\frac{3}{4}$; basal joint with strong pecten; in male shortly ciliated. Posterior tibiae with long dense hairs. Forewings with all veins present and separate, 7 to costa, 11 from middle; chorda and forked media present. Hindwings with all veins present and separate, 3 to 7 nearly parallel; forked media present.

Palaeoneura amictopis, n. sp.

ἀμικτωπις, unmixed, pure.

♂, 25 mm. Head, palpi, and thorax grey-whitish. Antennae grey-whitish, towards apex fuscous; ciliations in male $\frac{1}{2}$. Abdomen grey. Legs grey; posterior pair grey-whitish. Forewings suboblong, rather elongate, not dilated, costa

gently arched, apex rounded, termen obliquely rounded; grey-whitish; cilia grey-whitish. Hindwings over 1, apex rounded, cilia ½; grey-whitish; cilia grey-whitish.

Western Australia: Perth, in October, one specimen.

Lepidoscia monosticha, n. sp.

μονοστιχος, with single line.

♂, 15 mm. Head whitish; back of crown fuscous. Palpi, antennae, thorax, and abdomen fuscous. Antennal ciliations in male 1. Legs fuscous; posterior pair whitish. Forewings broadly spathulate, costa straight to ¾, thence arched, apex rounded, termen obliquely rounded; pale fuscous; an inwardly-oblique white line from ⅘ costa to ⅔ dorsum; cilia pale fuscous. Hindwings pale fuscous; cilia ⅔, pale fuscous.

Queensland: Stradbroke Island, in September, one specimen.

Lepidoscia chrysastra, n. sp.

χρυσαστρος, golden starred.

♂, 17-18 mm. Head dark fuscous with some ochreous hairs on crown. Palpi, antennae, and thorax dark fuscous. Antennal ciliations in male 3. Abdomen dark fuscous; beneath ochreous towards apex. Legs dark fuscous; posterior pair partly ochreous. Forewings dilated posteriorly, costa moderately arched, apex round-pointed, termen nearly straight, oblique; dark fuscous, markings pale ochreous; a spot on base of costa; a large triangular spot above dorsum near base; an acute, short, transverse mark on costa before middle, a dot beyond middle, and an elongate transverse triangular spot before apex; a long erect mark on dorsum before tornus, reaching middle of disc; a subterminal line; cilia fuscous. Hindwings fuscous; cilia ½, fuscous.

Western Australia: Perth, in October, two specimens.

Narycia cirrhosticha, n. sp.

κιρροστιχος, yellowish lined.

♂, 13-14 mm. Head pale ochreous; face and palpi fuscous. Antennae fuscous; ciliations in male 1. Thorax and abdomen fuscous. Legs fuscous; middle tarsi annulated with ochreous-whitish; posterior tibiae and tarsi ochreous-whitish. Forewings suboblong, costa gently arched, apex rounded-rectangular, termen nearly straight, slightly oblique; 7 and 8 stalked; fuscous; markings pale ochreous; a narrow fascia from ⅓ costa to near base of dorsum, expanding slightly towards dorsum; a second narrow fascia from ⅔ costa to tornus, slightly outwardly bent and rather constricted in middle; some obscure terminal dots; cilia fuscous. Hindwings subovate; 4 and 5 separate; grey; cilia ½, grey.

Queensland: Toowoomba, in October, two specimens.

Narycia euthygramma, n. sp.

εὐθυγραμμος, with straight markings.

♂, 14 mm. Head ochreous-whitish; face, palpi, and antennae fuscous. Thorax dark fuscous. Abdomen dark fuscous, towards base paler. Legs fuscous; tarsi annulated with whitish-ochreous; posterior pair, except tarsi, whitish-ochreous. Forewings moderate, costa rather strongly arched, apex pointed; 7 and 8 coincident; dark fuscous; three narrow, nearly straight, ochreous-whitish, transverse fasciae; first near base, slightly inwardly oblique; second from costa before middle to dorsum beyond middle; third from ¾ costa to tornus; cilia dark fuscous. Hindwings and cilia fuscous.

Queensland: Brisbane, in August, one specimen.

Narycia myriospila, n. sp.

μυριοσπιλος, with countless spots.

♀, 30-32 mm. Head, antennae, and thorax fuscous. Abdomen grey; tuft ochreous tinged. Legs grey; anterior pair fuscous. Forewings suboblong, costa gently arched, more strongly towards base, and there fringed with longer scales, apex round-pointed; 7 and 8 stalked; pale grey speckled with very numerous, minute, fuscous dots; a short, broad, fuscous bar from 1/3 costa, outwardly oblique to middle of disc; cilia pale grey, apices grey-whitish. Hindwings and cilia grey.

Queensland: Brisbane, in May and June, two specimens.

Narycia phaeostola, n. sp.

φαιοστολος, dusky clothed.

♂, 15 mm. Head pale ochreous; face and palpi fuscous. Antennae fuscous; ciliations in male 1. Thorax fuscous. Abdomen fuscous, beneath pale ochreous. Legs fuscous, suffused, and tarsi annulated, with pale ochreous. Forewings oval-oblong, costa strongly arched, apex round-pointed, termen very oblique; 7 and 8 coincident; fuscous slightly tinged with brown; an irregular whitish-ochreous spot at about 1/3 on fold; whitish-ochreous costal dots shortly before and after middle; cilia concolourous. Hindwings and cilia fuscous.

♀, 20-21 mm. Forewings more elongate, apex more acute; fuscous without brownish tinge; markings of male very obscurely indicated.

At first sight the sexes appear so different that I would not have placed them together if they had not been taken in the same locality.

Queensland: National Park (3,000 feet), in December and January, one male (type) and three female specimens.

Narycia sinuosa, n. sp.

Sinuosus, with many curves.

♂, 16-20 mm. Head ochreous-white. Palpi fuscous. Antennae fuscous; ciliations in male 1. Thorax and abdomen fuscous. Legs fuscous; tarsi annulated with whitish; posterior pair except tarsi whitish. Forewings elongate-oval, costa bisinuate, being moderately arched with slight median excavation, apex round-pointed; termen very oblique; 7 and 8 stalked; grey-whitish with numerous transverse fuscous strigulae; four or five fine interrupted transverse lines in basal third; sometimes a broader fascia at 1/2, its edges very irregular; a tornal fuscous spot, sometimes connected with a similar or larger spot on 2/3 costa, and sometimes one or more costal spots beyond this; cilia grey. Hindwings and cilia grey.

Queensland: Brisbane, in April and May, four specimens.

Narycia melanospora, n. sp.

μελανοσπορος, black spotted.

♂, 17 mm. Head whitish. Palpi fuscous. Antennae fuscous; ciliations in male 2/3. Thorax and abdomen fuscous; tuft whitish-grey. Legs fuscous; posterior pair grey. Forewings elongate, posteriorly dilated, costa slightly arched, more strongly towards apex, apex round-pointed; 7 and 8 stalked; whitish with scanty fuscous irroration and fuscous markings; dorsal spots at 1/4 and 2/3, each preceded by a discal spot; numerous costal dots with a larger spot at 2/3; a straight, irregularly edged fascia from 4/5 costa to tornus; a subterminal series of dots; cilia whitish. Hindwings and cilia pale grey.

New South Wales: Cooma (2,000 feet), in October, one specimen.

Narycia ischnomorpha, n. sp.

ἰσχνομορφος, of narrow shape.

♂, 14-16 mm. Head white; face and palpi fuscous. Antennae fuscous; ciliations in male ½. Thorax fuscous with a white transverse line behind middle. Abdomen fuscous; tuft whitish. Legs fuscous; posterior pair ochreous-whitish. Forewings narrow, oval, costa gently arched, apex round-pointed, termen very obliquely rounded; 7 and 8 very shortly stalked; whitish; numerous costal and dorsal fuscous strigulae; a large central roundish spot, connected by a bar with ⅔ costa, fuscous; a smaller discal spot at ¾; a subapical spot, sometimes white-centred; cilia whitish. Hindwings narrow-ovate; 4 and 5 approximated or stalked (in one example 5 absent on one side); grey; cilia ⅓, grey.

Queensland: Adavale, in April, four specimens.

Narycia leucochroa, n. sp.

λευκοχροος, white.

♂, 26 mm. Head white. Palpi fuscous. Antennae grey; ciliations in male ¼ Thorax white; anterior edge fuscous. Abdomen grey; tuft whitish Legs grey; posterior pair whitish. Forewings posteriorly dilated, costa strongly arched, apex round-pointed, termen very obliquely rounded; 7 and 8 coincident; white with general, scanty, pale-grey irroration; a pale-grey spot in disc above tornus, and another opposite beneath ⅔ costa; cilia white. Hindwings and cilia pale grey.

Queensland: Stradbroke Island, in January, one specimen.

Narycia conioptila, n. sp.

κονιοπτιλος, dusty winged

♂, ♀, 15-20 mm. Head whitish; face and palpi fuscous. Antennae fuscous, basal joint whitish; in male slightly serrate, minutely ciliated Thorax and abdomen fuscous. Legs fuscous; tarsi with fine whitish annulations; posterior pair ochreous-whitish. Forewings suboval, costa strongly arched, apex pointed, termen very obliquely rounded; 7 and 8 coincident; whitish; numerous fuscous strigulae tending to form fine interrupted transverse lines; two fuscous transverse fasciae; first from ⅓ costa to dorsum before middle, constricted or interrupted beneath costa; second from ⅔ costa to tornus, sometimes dilated in disc, constricted on tornus; cilia whitish. Hindwings grey-whitish; cilia whitish.

North Queensland: Kuranda, in August, three specimens received from Mr. F. P. Dodd.

Narycia lechriotypa, n. sp.

λεχριοτυπος, obliquely marked.

♂, 10-11 mm. Head white. Palpi fuscous. Antennae fuscous; ciliations in male 1. Thorax and abdomen fuscous. Legs fuscous; posterior pair paler. Forewings elongate-oval, costa strongly arched, apex rounded; 7 and 8 coincident; white with fuscous markings and strigulae; an elongate spot on base of costa; an outwardly-oblique bar from ⅓ dorsum to beyond middle of disc; a tornal spot; an outwardly-oblique bar from ⅔ costa towards but not reaching lower end of termen; cilia whitish. Hindwings and cilia pale grey.

North Queensland: Townsville, in September and October, two specimens.

Narycia acropolia, n. sp.

ἀκροπολιος, grey at ɑpex.

♂, 14 mm. Head ochreous-whitish; face and palpi fuscous. Antennae fuscous; ciliations in male ½. Thorax grey; tegulae ochreous-whitish. Abdomen pale grey. Legs fuscous; tarsi annulated with whitish; posterior pair ochreous-whitish. Forewings moderate, somewhat dilated posteriorly, costa rather strongly

arched, apex rounded; 7 and 8 coincident; whitish; markings fuscous-grey; a faint basal suffusion with a straight transverse posterior edge; a line from $\frac{1}{3}$ costa to middorsum, and another from $\frac{2}{3}$ costa to tornus angulated in disc; the included area between these lines faintly suffused, except a costal spot; an apical spot; a short line on lower part of termen; cilia ochreous-whitish. Hindwings and cilia pale grey.

Victoria: Beaconsfield, in October, one specimen.

Narycia niphospila, n. sp.

νιφοσπιλος, snow spotted.

♂, 22-24 mm.; ♀, 27 mm. Head white; face, palpi, and antennae brownish-ochreous. Thorax fuscous. Abdomen brownish-ochreous. Legs fuscous; posterior pair brownish-ochreous. Forewings moderate, costa rather strongly arched, apex round-pointed; 7 and 8 coincident; ochreous-fuscous, with numerous white spots; a basal white fascia; four costal spots, two before and two beyond middle; three dorsal spots, first near base; second before middle, fascia-like, reaching more than half across disc; third similar; a subdorsal dot between these two, and another dot on tornus; an apical spot, sometimes confluent with an oval submarginal spot which runs into termen and cilia above tornus; cilia ochreous-fuscous, apices whitish. Hindwings greyish-ochreous, slightly mottled posteriorly; cilia pale ochreous.

North Queensland: Stannary Hills, near Herberton, three specimens received from Dr. Thomas Bancroft.

Narycia tetramochla, n. sp.

τετραμοχλος, with four bars.

♂, 20-22 mm. Head white. Palpi fuscous. Antennae fuscous; ciliations in male $\frac{1}{2}$. Thorax dark fuscous with a white posterior spot. Abdomen whitish-ochreous. Legs fuscous; tarsi annulated with ochreous-whitish. Forewings moderate, costa rather strongly arched, apex round-pointed; 7 and 8 stalked; white; markings dark fuscous; a narrow basal fascia prolonged on costal edge to second fascia; second fascia at $\frac{1}{5}$, gradually dilated towards dorsum; third broader from $\frac{3}{5}$ costa, displaced outwards in middle, ending on dorsum beyond middle; fourth from $\frac{3}{4}$ and fifth from before apex, the two fusing in middle of disc and thence running to tornus; a streak along apical half of termen; cilia fuscous, before and above tornus ochreous-whitish. Hindwings grey; ochreous tinged towards dorsum; cilia whitish-ochreous, on apex grey.

Near *N. trifasciana*, Wlk., but the second and third fasciae are widely separate on costa. I have a series of that species from Brisbane, and its markings are very constant. The species following belongs to the same group.

New South Wales: Glen Innes, in March, two specimens.

Narycia dicranota, n. sp.

δικρανοτος, forked.

♂, 17-20 mm. Head white. Palpi fuscous. Antennae fuscous, ciliations in male $\frac{1}{2}$. Thorax dark fuscous with a white posterior spot. Legs fuscous; tarsi annulated with whitish-ochreous; posterior pair except tarsi whitish-ochreous. Forewings moderate, costa rather strongly arched, apex round-pointed; 7 and 8 stalked, separating not far from apex; white; markings fuscous; a narrow basal fascia slightly produced on costa; a fascia from $\frac{1}{3}$ costa dividing in middisc, anterior arm to $\frac{1}{3}$, posterior to $\frac{2}{3}$ dorsum; a fascia from $\frac{2}{3}$ costa joined by another from before apex, and ending on tornus; sometimes one or two fuscous dots on termen; cilia whitish-ochreous; before apex and

on tornus mixed with fuscous. Hindwings pale grey, sometimes mottled with whitish-ochreous; cilia whitish-ochreous.

The forewings are pure white; in *N. trifasciana* they are slightly ochreous tinged with slight fuscous irroration, and the markings are darker and broader. Though extremely similar the differences appear constant.

Queensland: Brisbane, in March and April; Toowoomba, in April; three specimens.

NARYCIA PELOCHROA, Meyr.

I have a second female example of *N. leuceres*, Turn., from Stradbroke Island, but have found no male to correspond, and now regard it as merely a pale form of the female of *N. pelochroa*.

Mesopherna epomadia, n. sp.

ἐπωμαδιος, marked on the shoulders.

♂, ♀, 14-22 mm. Head whitish; face and palpi dark fuscous. Antennae ochreous-whitish. Thorax white; bases of patagia fuscous. Abdomen pale ochreous-grey. Legs fuscous; posterior pair ochreous-whitish. Forewings moderate, oval, costa rather strongly arched, apex rounded, termen very oblique; 7 and 8 approximated at origin, 7 to costa; white with sparse dark-fuscous irroration; a strong dark-fuscous costal streak from base to about ⅓; sometimes a suffused spot on middorsum; cilia white irrorated with fuscous and grey. Hindwings with 5 and 6 approximated at origin; pale grey; cilia pale grey.

Queensland: Brisbane, in December and February; Coolangatta, in October; four specimens.

Mesopherna niphopasta, n. sp.

νιφοπαστος, sprinkled with snow.

♀, 15 mm. Head white; face blackish. Palpi blackish; extreme apex of labial palpi white. Antennae fuscous, towards base white. Thorax white. Abdomen grey; in female with large apical tuft. Legs fuscous; posterior pair grey except tarsi, which are fuscous with fine whitish annulations. Forewings dilated posteriorly, costa gently arched, more strongly so towards apex, apex round-pointed; 7 and 8 separate; 7 to costa; grey, rather densely sprinkled with white dots; a broad white median streak from base to ¾, its inferior edge ill-defined; a blackish dot on fold at ½; another larger and irregular at ⅔ in median streak; a few blackish scales towards dorsum and in median streak; an interrupted, blackish, terminal line; cilia white, apices blackish, a curved, basal, blackish line on costa and around apex, continued as an indistinct subapical line to tornus. Hindwings elongate-ovate, apex pointed; 5 and 6 approximated at origin; pale grey; cilia ½, pale grey.

Queensland: Gayndah, one specimen received from Dr. Hamilton Kenny.

Ardiosteres crossospila, n. sp.

κροσσοσπιλος, with marginal spots.

♂, ♀, 14-17 mm. Head pale-fuscous. Palpi whitish-ochreous with a few fuscous scales. Antennae pale fuscous; in male thickened and shortly ciliated ⅓. Thorax and abdomen fuscous. Legs fuscous; posterior pair whitish-ochreous, fuscous tinged. Forewings broadly oval, costa strongly arched, apex rounded, termen very oblique; 7 and 8 stalked, 7 to termen; rather pale fuscous with some darker scales; markings ochreous-whitish; a subquadrate spot on ⅓ costa, its lower angles slightly produced; a dot on midcosta and a small spot on about ⅔; an oblique wedge-shaped spot on middorsum, its apex outwards; dorsal dots at ¾ and tornus; a median subterminal dot; a wedge-shaped spot on termen beneath apex; cilia fuscous, on terminal spot whitish. Hindwings and cilia grey.

Queensland: National Park (1,500 to 3,000 feet), in December and March, three specimens.

Gen. **Azaleodes**, nov.

ἀζαλεώδης, of dry, withered appearance.

Head and face rough-haired. Palpi rather long, ascending, exceeding vertex, stout but laterally compressed, shortly rough-scaled; terminal joint about ½, as stout as second joint. Maxillary palpi long, slender, folded. Posterior tibiae smooth above, shortly hairy beneath. Forewings with all veins present and separate, 2 from near angle, 3 and 4 approximated from angle, 7 to termen, 11 from near base. Hindwings with all veins present and separate, 2 from ⅗, 3, 4, 5, 6, 7 approximately equidistant, a forked median vein in cell.

Probably related to *Ardiosteres*, but more primitive.

Azaleodes micronipha, n. sp.

μικρονιφος, minutely snow-white.

♀, 26 mm. Head, palpi, antennae, and thorax brown. Abdomen fuscous; brown towards base. Legs brown; anterior and middle tibiae and tarsi fuscous. Forewings suboblong, costa strongly arched to ¼, thence nearly straight, apex rectangular, termen straight, scarcely oblique; brown with scattered fuscous irroration; a snow-white, median, discal dot at ¼, and another at ⅗; cilia brown Hindwings slightly over 1; pale grey; cilia pale grey.

Queensland: National Park (3,000 feet), in December, one specimen.

Gen. **Tanymita**, nov.

τανυμιτος, with long threads.

Head and face densely rough haired. Tongue absent. Labial palpi long, ascending, recurved; second joint very long, expanded towards apex, rough haired anteriorly towards apex; terminal joint short, stout, acute, rough haired anteriorly and posteriorly. Maxillary palpi rather stout, three-jointed, slightly expanded with rough hairs at apex. Antennae about ½, in male slightly serrate. Posterior tibiae clothed with long hairs. Forewings with 2 from well before angle, 4 and 5 coincident in male, in female connate, remaining veins separate. Hindwings with 4, 5, 6 equidistant, parallel, 6 from upper angle, 7 from well before upper angle of cell.

Tanymita hypomacra, n. sp.

ὑπομακρος, rather long.

♂, 24-27 mm.; ♀, 32-36 mm. Head ochreous-whitish with some fuscous hairs on crown. Palpi ochreous-whitish with some dark-fuscous irroration. Antennae ochreous-whitish. Thorax ochreous-whitish with five longitudinal fuscous-brown lines. Abdomen grey. Legs ochreous-whitish; posterior tibiae grey on dorsum. Forewings rather long, suboval, apex rounded; ochreous-whitish with numerous fine longitudinal fuscous lines; in posterior area these run in pairs, the space between them being pale ochreous; cilia ochreous-whitish with a few fuscous points. Hindwings as broad as forewings; grey; cilia grey.

North Queensland: Thursday Island; Kuranda, in April; Cairns; Innisfail, in November; five specimens.

Ptychoxena tephrantha, Meyr.

Meyr., Exot. Micro., i., p. 616 (1916).

Mr. Meyrick identified this for me. My examples do not agree with all the details of his description, and doubtless the species is variable.

North Queensland: Kuranda, in October; Queensland: Brisbane; Coolangatta, in April; also from Ceylon, India, Africa, and South America.

Monopis cirrhospila, n. sp.

κιρρoσπιλος, spotted with pale yellow.

♂, 16 mm. Head pale yellow. Palpi fuscous. Antennae yellowish, suffused with grey except basal joint; ciliations in male $\frac{1}{2}$. Thorax fuscous-brown. Abdomen pale yellow. Legs pale yellow; anterior pair fuscous. Forewings suboval, costa strongly arched, apex rounded, termen very oblique; fuscous-brown; a pale-yellow dorsal blotch before middle; similar but larger blotch on costa from $\frac{3}{8}$ to $\frac{7}{8}$, triangular and extending beyond middle, indented just posterior to its apex; five or six fuscous dots betweeen the two blotches; cilia yellowish irrorated with fuscous-brown. Hindwings pale grey; cilia pale yellow.

Northern Territory: Darwin, one specimen received from Mr. G. F. Hill.

Monopis ochroptila, n. sp.

ὠχροπτιλος, pale winged.

♂, ♀, 11-20 mm. Head and palpi pale ochreous. Antennae grey. Thorax and abdomen pale ochreous-grey. Legs whitish-ochreous; anterior and middle pairs with some fuscous suffusion. Forewings narrow, costa slightly arched, apex round-pointed, termen very oblique; pale ochreous-grey; cilia concolourous. Hindwings similar but paler, sometimes more greyish.

Queensland: Dalby, in April; Adavale, in April; Victoria: Birchip; six specimens.

Gen. Sarocrania, nov.

σαροκρανιος, brush headed.

Head and face very densely rough haired. Labial palpi moderate, slender, drooping; second joint with a few long hairs; terminal joint as long as second, acute. Maxillary palpi long folded. Antennae about $\frac{3}{4}$; without pecten; in male rather stout, simple. Posterior tibiae with long hairs on dorsum. Forewings narrow; 7 and 8 stalked out of 6, 7 to termen. Hindwings lanceolate; 4 absent, 6 and 7 stalked.

A derivative of *Tinea*. I have some difficulty in making out the complete neuration, but think vein 4 is absent in both wings.

Sarocrania ischnophylla, n. sp.

ισχνοφυλλος, narrow winged.

♂, 11 mm. Head ochreous-brown. Palpi, antennae, and thorax grey. Abdomen whitish-grey. Legs fuscous; posterior pair whitish-grey. Forewings narrow, apex rounded; smooth shining grey; cilia grey. Hindwings lanceolate; pale grey; cilia $2\frac{1}{2}$, pale grey.

Queensland: Mount Tambourine, in November; one specimen.

Tinea niphoplaca, n. sp.

νιφοπλακος, with broad snow-white spots.

♀, 13 mm. Head snow-white. Palpi blackish; terminal joint whitish. Antennae dark fuscous. Thorax blackish. Abdomen dark fuscous. Legs fuscous; posterior pair grey, tarsi with whitish annulations. Forewings moderate, costa gently arched, apex rounded; blackish; a broad snow-white fascia at $\frac{1}{4}$, narrowed almost to a point on costa, anterior edge straight, posterior rounded; a large snow-white spot on $\frac{2}{3}$ costa, broadest on costa, inferior edge rounded; a white subapical dot; cilia pale grey; bases blackish. Hindwings broadly lanceolate; grey; cilia $\frac{2}{3}$, grey.

Northern Territory: Stapleton, one specimen received from Mr. G. F. Hill.

Tinea drymonoma, n. sp.

δρυμονομος, haunting the woods.

♂, ♀, 10-13 mm. Head ochreous-whitish. Palpi fuscous, apex and internal surface ochreous-whitish. Antennae ochreous-whitish with some dark-fuscous scales. Thorax fuscous, a posterior spot, apices of patagia, and sometimes an anterior spot ochreous-whitish. Abdomen pale ochreous-grey. Legs ochreous-whitish; anterior and middle tibiae and tarsi dark fuscous with ochreous-whitish annulations. Forewings slightly dilated posteriorly, costa moderately arched, apex round-pointed, termen obliquely rounded; ochreous-whitish, markings and some scattered scales brownish mixed with dark fuscous; a spot on fold before middle, and sometimes another after middle; a larger spot on or beneath costa at ⅔; an apical spot; an interrupted dark-fuscous terminal line; cilia ochreous-whitish. Hindwings ovate-lanceolate; pale grey; cilia grey-whitish.

Queensland: National Park (2,500 to 4,000 feet), in December and January, abundant.

Tinea trigonosema, n. sp.

τριγονοσημος, with triangular marking.

♂, ♀, 10-12 mm. Head white. Palpi white, basal half or more of external surface of second joint fuscous. Antennae in male whitish, in female annulated with fuscous, with darker rings towards apex, in male annulated towards apex only. Thorax whitish. Abdomen grey. Legs whitish; anterior and middle tibiae and tarsi broadly annulated with dark fuscous. Forewings narrow, costa moderately arched, apex rounded, termen very oblique; whitish with scanty fuscous irroration; a fuscous suffused spot on base of costa; a fuscous triangle on costa at ⅓, and a fuscous spot at ⅔; some dark-fuscous scales on fold towards extremity, and a patch of dark-fuscous irroration in disc before third costal spot; a subapical dark-fuscous spot; cilia whitish with some fuscous points and a fine, pale, subapical grey line. Hindwings and cilia pale grey.

North Queensland: Kuranda, in September, two specimens received from Mr. F. P. Dodd.

Tinea pherauges, n. sp.

φεραυγης, shining.

♀, 9 mm. Head, palpi, and thorax fuscous-grey. Antennae grey-whitish. Abdomen grey. Legs grey; posterior pair whitish. Forewings rather narrow, apex rounded; pale shining leaden-grey; cilia grey. Hindwings lanceolate; grey; cilia 3, grey.

New South Wales: Ebor (4,000 feet), in January, two specimens, of which one is in Coll. Meyrick.

Tinea diacrita, n. sp.

διακριτος, distinguished.

♂, 18-22 mm. Head, thorax, and antennae pale ochreous-grey. Palpi dark fuscous; inner surface pale ochreous-grey. Abdomen whitish-grey. Legs whitish-grey; anterior pair fuscous. Forewings moderately elongate, costa moderately arched, apex pointed, termen very obliquely rounded; pale ochreous-grey with some slight fuscous irroration; a thick, irregular, dark-fuscous, submedian streak from base of costa to ⅔, with two projections beneath, first about middle of disc, second at its posterior extremity; two short elongate dark-fuscous subcostal dots about middle, arranged longitudinally; cilia ochreous-whitish with a fuscous median line and postmedian fuscous bars. Hindwings and cilia grey-whitish.

Queensland: National Park (2,500 feet), in December and January; New South Wales: Lismore, in October, five specimens.

THE EXTERNAL CHARACTERS OF POUCH EMBRYOS OF MARSUPIALS.

No. 7—MYRMECOBIUS FASCIATUS.

By F. Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read August 9, 1923.]

The "Numbat" *(Myrmecobius)* is, at the present time, one of the rarest marsupials, and is an animal which is particularly difficult to obtain in any stage. I am, therefore, fortunate in being able to examine five young examples in a good state of preservation. One of these, which measures 23 mm. R.V. measurement, I have been permitted to examine owing to the kindness of the authorities at the Perth Museum. The other four, which are of an approximate length of

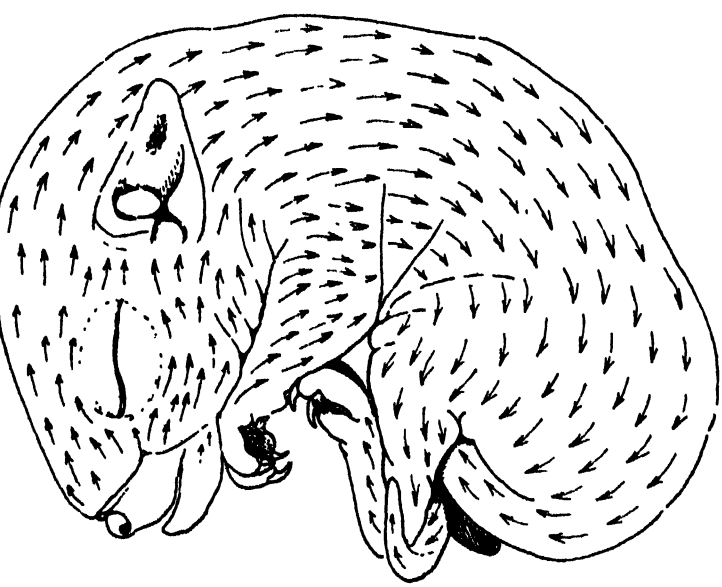

Fig. 1.
Myrmecobius fasciatus.
Hair tracts of embryo 75 mm. maximum H.B. length.

45 mm. R.V. measurement, and a maximum head and body length (measured along the curve of the back) of 75 mm., were collected along with the mother in Western Australia. These four, more advanced, young were clinging to the elongated nipples of the mother, and were thus suspended without receiving any protection whatever, save that may be afforded to their heads by the hispid hair of the mother's ventral surface. Although these four young animals are so relatively large and far advanced, their lip margins are still fused over the greater portion of their extent; and it is evident that their liberation from the nipples was not soon about to take place.

The young are very remarkable in their general appearance, and by far their most outstanding feature is the curious shortening of the muscle, which

produces a facial appearance distinctly reminiscent of that of a pug dog. The whole of the muzzle region appears to be thrust back towards the face, so that it becomes pressed beneath an over-growing fold of skin. It would be difficult to find young animals, at the stage of development represented by the completion of hair growth, more unlike the adult than these pug-faced young are to the parent animal with its specialized, elongated muzzle and jaws. No doubt the exacting business of hanging suspended from a nipple without the support afforded by a pouch plays some part in the production of this curious facial development; nevertheless, the young of the Bandicoots show the typical elongated snout of the adult during pouch life, despite the absorbing role of nipple grasping. (See No. 3 of this series, *Isoodon barrowensis,* vol. xlvi., 1922, fig. 4, p. 42.) The young animal at the conclusion of its dependent life should afford an interesting study in the readjustment of the cranial skeleton, for a young skull, 14 mm. in total length, shows an ossific facial architecture which is so unlike that of the adult that it is necessary for very remarkable changes to be brought about in a comparatively short interval. Many interesting problems connected with the development of *Myrmecobius* will, however, probably remain unsolved for lack of material. It is now a very rare animal; it seems impossible to obtain living specimens, and I know of no records of their having been bred in captivity.

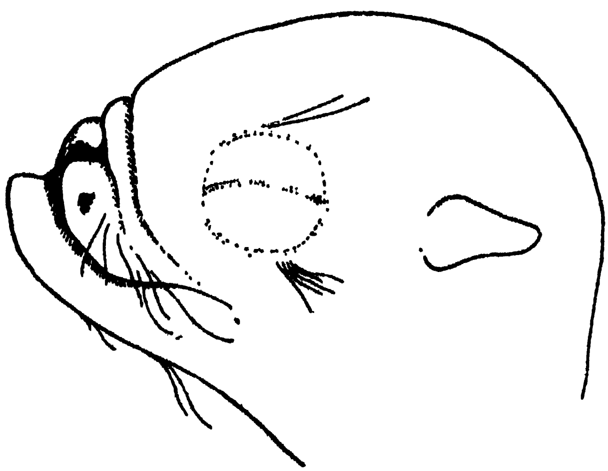

Fig. 2.
Myrmecobius fasciatus.
Facial vibrissae of a 23 mm. R.V. embryo.

Hair.—Hair is present on the head of the 23 mm. R.V. specimen. It is sparse, coarse, and nearly erect. At this stage it is not pigmented, and it is confined to the head and face. The larger embryos are completely hair-covered, but the growth of hair is more sparse upon the hinder end of the body and upon the limbs than on the head and face. The hair becomes appreciably shorter when traced caudad. It is all particularly coarse, and, at this stage, it is difficult to distinguish body hairs from true vibrissae. This is especially the case upon the face, where coarse bristle hairs on the eyelids, and behind and in front of the eye, mask the true vibrissae, which were fully developed at the 23 mm. R.V. stage in the absence of the coarse facial hairs. In the larger embryos the hair is pigmented, there being entirely black hairs interspersed with the colourless hairs. These black hairs are present upon the face, head, and shoulders, but are absent on the hinder end of the body. The red hairs typical

of the adult are suggested only by some minute hairs on the ears and upon the tip of the tail. Besides the black hairs which are scattered here and there among the pale hairs of the head and shoulders, there are patches upon the face in which the black hairs are alone developed. Between the eye and the ear is a

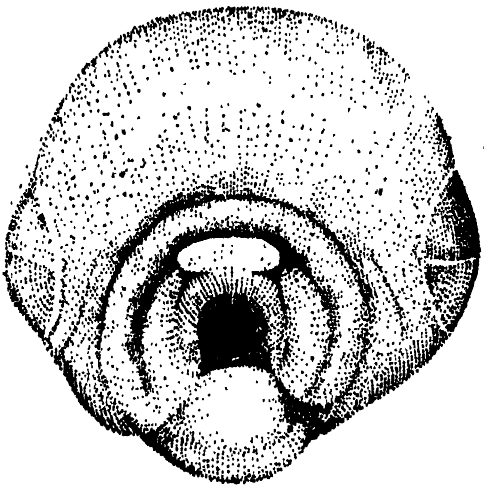

Fig. 3.
Myrmecobius fasciatus.
Full face view of head of embryo 23 mm. R.V. to show the characters of the rhinarium.

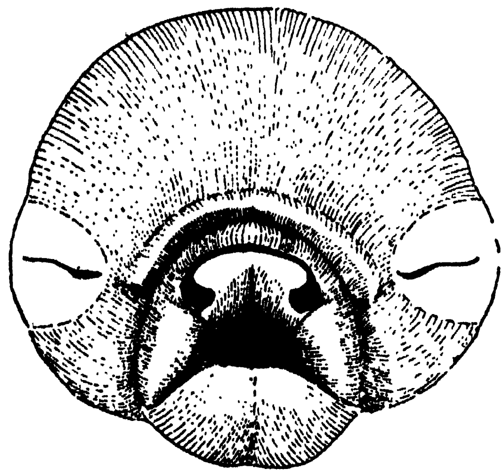

Fig. 4.
Myrmecobius fasciatus.
Full face view of head of embryo 75 mm. maximum H.B. length to show characters of the rhinarium.

patch of black hairs—the best developed hairs on the whole body—which make a very conspicuous feature in the embryo at this stage. In front of the eye is a similar, smaller patch; but this, at this stage, is involved in the folding of the facial wrinkle behind the shortened muzzle. Scattered black hairs are also present on the eyelids, black eyelashes are well marked, and all the true sensory vibrissae are black.

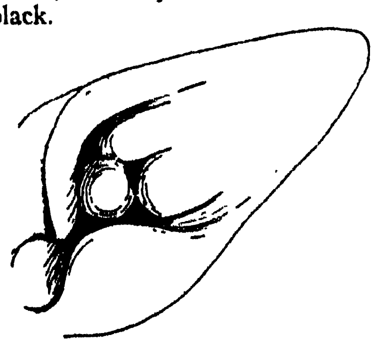

Fig. 5.
Myrmecobius fasciatus.
Left auricle of specimen 75 mm. maximum H.B. length.

The skin of the older embryos is also pigmented, the whole animal being a pale bluish-slate-grey, save where the pigment fails to be developed. The muzzle, the head and face, with the exception of the large eyelids, are pale slate coloured. The chin is deeply pigmented. The throat and the neck below and behind the ear are free of pigment. The face behind the eye is pigmented

and clothed with black hair, and the cheek immediately below and behind the eye shows slight pigmentation. The external ear is pigmented on both aspects. The ventral surface of the body lacks pigment, but the dorsum of the trunk and the limbs are pale blue-grey. The tail is more strongly pigmented at the base than at the tip. The black and white colouration of the hair, the absence of any suggestion of band markings, and the bluish pigmentation of the skin increase the great unlikeness to the rufus adult which the young animal displays in its general form.

Hair Tracts.—The arrangement of the coarse hispid hair in the fully-haired young is extremely simple. On the muzzle, face, head, trunk, and tail the slope is uniformly caudad. Upon the hind limb the slope is distal and post-axial. Upon the humeral portion of the fore limb it is post-axial, but upon the forearm it is post-axial and proximal in direction; there being, therefore, a slight tendency to converge in the region of the elbow (see fig. 1). The slight proximal trend of the hairs on the forearm constitutes the only trivial exception to the otherwise caudad, distal, and post-axial direction of the hair.

Vibrissae and Papillae.—The sensory papillae and vibrissae are undoubtedly undergoing reduction. The facial vibrissae are sparse and poorly represented, and have no marked papillae for their origin. The only papillae which

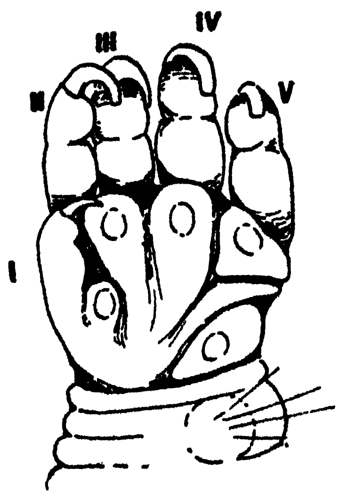

Fig. 6.
Myrmecobius fasciatus.
Left manus of specimen 75 mm. maximum H.B. length. Note the ulnar carpal papilla and its four vibrissae.

Fig. 7.
Myrmecobius fasciatus.
Left pes of specimen 75 mm. maximum H.B. length.

reaches any degree of prominence is the ulnar carpal (see fig. 6), and this wanes as development proceeds, even its vibrissae being unrecognizable in the adult. Vibrissae are present in the 23 mm. R.V. embryo when the scalp hairs are appearing; in later stages they are more difficult to recognize owing to their likeness to the hispid hairs of the general body covering.

Facial Vibrissae (see fig. 2).—The mysticial set consists of a few irregular vibrissae which do not arise in any recognizably ordered manner. Most of the individual bristles are not straight, as such sensory vibrissae usually are, but are waved in direction. Two supra-orbital bristles are present. The sub-mentals and interramals soon lose their identity and merge with the general coarse body hairs. The genals are represented by a tuft of about half a dozen black bristles which are inconspicuous in older embryos. No facial vibrissae have any definite papillae of origin.

Brachial Vibrissae.—The ulnar carpal papilla is the only one present, and it remains fairly well marked during dependent life. Four vibrissae spring from it, but with the development of hair on the forearm the individuality of the bristles becomes lost.

Rhinarium.—The muzzle region is one of the most interesting features of the young Numbat. The 23 mm. R.V. specimen (full face, fig. 3; side face, fig. 2) shows a perfectly circular mouth, and above it the nasal process as a

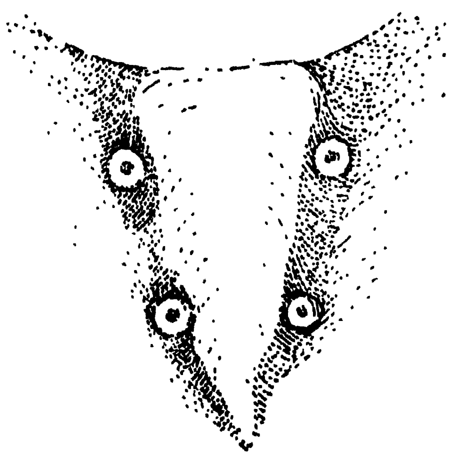

Fig. 8.
Myrmecobius fasciatus.
Mammary area of a female specimen 75 mm. maximum H.B. length.

flattened ridge. Upon either side of the nasal process are the maxillary processes completing the maxillary portion of the mouth. Surrounding these processes is a wide roll of skin of the muzzle, separated from the rest of the skin of the face by a deep furrow limiting it posteriorly; another furrow marking it off from the nasal process. The rhinarium is strikingly retreated and the mandibular portion of the face is considerably in advance of the maxillary portion. The site of the anterior nares is at the lateral margin of the simple nasal process. In the 45 mm. R.V. embryo (full face, fig. 4; side face, fig. 1) the protrusion of the mandibular portion of the face is not so well marked, and the formation of the nostrils has proceeded very considerably. The roll of skin behind the rhinarium has become less conspicuous, though it is still a well-marked feature. The junction of the nasal and maxillary processes has completed the upper lip; the portion of nasal process entering into the formation of the lip being a large one.

Chest Gland.—In no specimen have I been able to detect any external sign of the chest gland described by Beddard in the adult.

External Ear (see fig. 5).—The ear of the 23 mm. R.V. specimen is so moulded by the epitrichium that no sculpturing is to be detected; it is directed

backwards and is closely adherent to the side of the head. In the 45 mm. R.V. specimens the ear is pointed and fleshy; it is directed backwards and is free of the side of the head. A conspicuous and rounded processus antihelicis is present. There is a definite antitragus fold, and a less conspicuous tragus. Foldings of the concha distal to the processus are inconstant.

Manus (see fig. 6).—The digital formula is $4 > 3 > 2 > 5 > 1$; in the adult the second digit is as long as or longer than the third. The manus is relatively large. The four inter-digital pads are marked at their highest points by well-defined central areas. The pad at the base of the first digit is the smallest. The hypothenar pad is well developed. The claws are strong and curved.

Pes (see fig. 7).—The digital formula is $3 > 4 > 2 > 5$, as in the adult. One large pad with a central trefoil area is situated at the bases of digits 3 and 4; and smaller pads, with circular central areas, at the bases of digits 2 and 5. A small pad marks the site of the absent first digit. Claws are not so strongly developed on the pes as they are on the manus in the young animal.

Mammary Area (see fig. 8).—The four mammary primordia are situated in two furrows which run on the lower part of the abdomen and converge towards the caudal end. The area between these two furrows is elevated; the "pouch area" being thus marked by a raised wedge-shaped swelling of the abdominal wall, the apex of the wedge being directed caudad. The mammary primordia are marked as rounded elevations in the furrow, the summit of each of the elevations being invaginated so as to form a dimple in the centre of the prominence.

External Genitalia.—The genital tubercle in the male 45 mm. R.V. embryo is conspicuous beyond the limits of the cloacel margin; in the female of the same size the condition is similar save that the genital tubercle is rather less conspicuous.

A SURVEY OF THE AUSTRALIAN SHEEP MAGGOT-FLY PROBLEM.

By T. Harvey Johnston, M.A., D.Sc., Professor of Zoology, University of Adelaide.

[Read August 9, 1923.]

Though a sheep blowfly problem occurs in Great Britain, South Africa, New Zealand, and some of the Pacific Islands, it is in the eastern half of Australia that it has developed more especially. In North America there is a myiasis affecting stock, caused by the screw worm, *Compsomyia macellaria,* but it is of a quite different type from that occurring in the countries mentioned. At least forty years ago certain blowflies were known to deposit their eggs or larvae in injuries on ram's heads (caused by fighting), on blankets, saddle cloths, and wool bales, but it was not till about 1896 that infestation of lambs was noticed. The latter occurred after marking and tailing. Following the drought years 1900 to 1902, fly infestation became more and more pronounced, Froggatt referring to the matter early in 1905, again in 1910, and frequently since then. In Queensland the invasion became so bad that in 1913 Cory and Jarvis were commissioned to inquire into the matter and found that out of over one million sheep in a district in Central Queensland an average of 23 per cent. had been "struck," and that on some "stations" from 40 per cent. to 70 per cent. of the animals were affected. They recommended that experiments with various traps, dip fluids, and dressings should be carried out by the Government, this being begun in 1914 and continued for four years at Gindie, near Emerald, Central Queensland (R. S. C., 1922, p. 45).

A very good account of the damage done to sheep and wool, and the commoner sites of infestation, has been published by Froggatt (1913, p. 16; 1915, pp. 12, 13). In the preceding paragraph an indication of the seriousness of the infestation in Central Queensland is given. Froggatt and Froggatt (1916, pp. 28-30) published a return of the total sheep and estimated losses from blowfly infestation in New South Wales for the year 1914, from information forwarded by the district stock inspectors. It showed that the amount varied in different districts from nil to as much as 8 per cent., the total estimated loss for the State during the period being about 1 3 per cent. Russell (Editor, 1921, p. 250) stated that the losses in 1920 from fly attacks in two Queensland "stations" were estimated at about 15,000 sheep in each case, all the sheep being almost fully fleeced. The writer was informed in 1920 by Messrs. Russell (of Dalmally, Roma) and W. G. Brown (Sheep and Wool Expert, Dept. of Agriculture, Queensland) that the losses from fly probably averaged 5 per cent. of Queensland flocks—a loss as great as that from all natural causes combined (old age, lambing, accidents, and disease). The loss is even greater in New South Wales, where sheep raising is carried on more extensively. Fly infestation also occurs, but to a less extent, in Victoria, Tasmania, South Australia, and Western Australia. The annual loss, both directly and indirectly, must aggregate some millions of pounds sterling. McLeod and Holme (in Cooper, 1913, p. 55) estimated the direct damage in New South Wales during the season 1909-1910 at £377,700, and mentioned that in one station in that State fully 60 per cent. of the sheep shorn in March became attacked, and, as a consequence, a later date was fixed for subsequent shearings with improved results.

In the *Sydney Morning Herald* of December 28, 1921, it was stated that the destruction of sheep and lambs, the reduction in wool, and other losses

directly due to the attacks of blowflies cost Australia over five millions sterling per annum.

The time of the year when these flies are troublesome to sheep varies in the different parts of the Commonwealth and even in different years in the same district. Cooper collected information regarding blowfly prevalence and tabulated it in 1913. The worst periods were stated to be from March to May, and September to October, with some infestation in certain localities during winter (June to August), but probably none during summer (December to February). The chief periods are during autumn and lambing time. In Queensland, flies make their presence felt whenever there is a good fall of rain (1 or 2 inches), regardless of the time of the year (R. S. C., 1922, p. 45), and sheep may be badly attacked during the period February to October (R. S. C., in Knibbs, 1922). Froggatt (1913, p. 15) stated that warm showery winters are especially favourable for infestation which may appear as early as March, or may be delayed till several months later. Place mentioned in 1922 that infestation was not especially noticed in South Australia until ten or twelve years previously, and that it occurred particularly in March, April, or May (being worst in the last-named month), and again in spring. These periods correspond approximately with those in Tasmania, Victoria, and New South Wales. In New Zealand, Miller (1921) reported that though infestation might occur in winter, it was especially prevalent during lambing season in the spring, continuing to December, and appearing again in the autumn. Gilruth called attention to its occurrence in summer in North Otago, in the Dominion (1907).

In the earliest accounts of Australian infestation, the culprits were reported by Froggatt (1905, 1910) to be the two commonest native blowflies, *Calliphora oceaniae,* and *C. villosa,* now known as *Anastellorhina augur,* Fabr., and *A. stygia,* Fabr., respectively (Johnston and Hardy, 1922). The latter occurs also in New Zealand as a sheep maggot-fly (Miller, 1921). Woodburn (in Cooper, 1913) stated that the "hairy maggot" *(i.e.,* the larva of *Chrysomyia albiceps)* was one of the worst offenders, while Froggatt later (1913) included it (as *Calliphora rufifacies)* along with the two mentioned, but stated that it was of minor importance. Several other flies were referred to by him, but it was stated that they had not been bred from live wool, though they had been bred out from carcases. They were *C. varipes, Lucilia sericata, L. caesar,* and *Ophyra nigra.* Subsequently some of these were reported as blowing wool on sheep. In 1915 the same author stated that *C. albiceps* was the chief blowfly of sheep, and gave an account of the main flies and their larvae, adding species of *Sarcophaga* to the list (1914b, 1915). The species which have been reported by Froggatt as breeding in wool in Australia are *A. augur, A. stygia, C. albiceps, C. varipes, L. sericata, Sarcophaga* sp., and *Ophyra nigra.* Taylor (Proc. Linn Soc. N.S. Wales, May, 1920) stated that *Lucilia fuscina,* Wlk., was one of the sheep maggot-flies in Queensland, where it had been confused with *L. sericata.* The writer of this article has also pointed out that more than one species is included under this latter term in Australia (Johnston, 1921, p. 245; 1922, p. 273; Johnston and Tiegs, 1922, p. 79).

It is not yet known whether one kind of blowfly leads the attack and sets up conditions which attract others. The following facts are of interest:—(1) That the commonest blowflies, *A. augur* and *A. stygia,* not uncommonly blow woollen materials (blankets, bales, etc.); (2) that they were the first reported by Froggatt as infesting sheep; and (3) that one of them has been recorded by Miller as causing trouble in New Zealand. They suggest that these flies may be the primary cause. As species of *Lucilia* are known to be culprits in Great Britain, South Africa, and New Zealand, it is not unlikely that they may act similarly in the Commonwealth, where they are very common around carrion.

In parts of South Africa and in Australia, species of *Pycnosoma (Chrysomyia)* are known to blow sheep, and in the latter country are now regarded as the chief cause of such myiasis. Patton, however, has stated that these flies in the final maggot stage are predators on the larvae of other blowflies; hence the possibility that others may initiate the attack and the "hairy maggots" may actually be present (at least in part) in the role of destroyers of the culprits, and as a consequence the flies bred out from such infested wool would be chiefly *Pycnosoma*. This point has not been cleared up yet. The writer has bred the two "hairy maggots" in abundance from carrion, but the larvae of other blowflies were also present as a rule, and it is probable that *Pycnosoma* is present on sheep in the dual role of carrion feeder and predator.

Froggatt has frequently drawn attention to the change of habit in the case of these various blowflies which were at first carrion feeders, the adults depositing eggs or larvae on or in dead animals, and ultimately coming to attack wool on living sheep. The writer of the present article does not see any reason to assume a change of habit. Flies are readily attracted to those places where bacterial decomposition is going on and oviposition is stimulated. Soiled wool contains abundant bacteria and a chemotropic influence is soon sufficiently pronounced to attract pregnant blowflies, which deposit their eggs or larvae on the wool. In part of the area in which larval activity is first manifested there will commonly be noticed a more or less pronounced greenish discolouration, no doubt caused by bacterial agency, which is secondarily augmented by the presence of the maggots. This seems to pave the way for the larvae which are then feeding in dead and decomposing wool and foreign material until such time as they reach the skin, when the irritation caused by their presence, and probably also the attempts of the sheep to dislodge them, may lead to a breaking of the skin on the fevered part, bacterial infection of the injury soon occurring when the maggots are thereby able to get inside the damaged tissue. If this view be correct, then one very important line of attack against sheep myiasis would be to check bacterial activity. According to an article in the Australian daily Press during last December, Dr. W. Sinclair advocates using a solution containing one part of mercury in 500,000, which, he claims, is taken up from the skin, enters the blood, and becomes excreted through the sweat and yolk glands, reaching the wool and skin, where bacterial invasion is then checked; but if sheep be already blown and the skin broken, then direct application to the moist area is needed, when the bacteria are destroyed, the maggots drop off, and the wound soon heals. The method has not, as far as I know, been fully investigated.

There are certainly predisposing factors towards fly attack. It has been pointed out by Froggatt (1905, 1913, 1915, 1922) that the sheep breeder has changed the character of the Australian merino by making practically every part of the animal produce wool, and even by encouraging the development of a wrinkled skin in order to give a greater wool-producing surface. Hence the wool is extremely fine and dense, and even the rump portion, which is so readily soiled, now carries a mass of wool. "This artificial increase in weight, quantity, and fineness of wool is accompanied, too, by an increased secretion of yolk, which, rising from the skin and spreading all through the wool fibre, forms an additional attraction for the flies and supplies food for the maggots" (Froggatt, 1922). Any circumstance which causes diarrhoea favours fly attack, as also does the act of lambing, merely through soiling the wool of the breech of the animals. Even urine may bring about a similar result, and once such dense wool becomes infested, the maggots are soon able to work their way into the warm, moist, bacteria-laden wool and pass through their stages under optimum conditions. The docking and marking of lambs gives flies a further opportunity

on account of the likelihood of bacterial invasion taking place during these operations.

Woodburn (in Cooper, 1913, p. 50) stated that ewes, lambs, weaners, and merino sheep (especially if wrinkled) were more liable to attack than plain-bodied sheep, and that wethers were less affected than ewes. He published a table of percentages. Out of 6,000 weaners, merino ewes showed a loss of 40 per cent., merino wethers 3 per cent., Lincoln-merino crossbred ewes 15 per cent., and crossbred wethers nil.

One possible method of controlling the problem may be the breeding either of crossbreds or of a merino devoid of a wrinkled skin and of heavy wool on the rump region. This would more or less obviate the necessity for crutching sheep. The Queensland Blowfly Committee, in a pamphlet issued in December, 1920, stated that sick or worm-infested sheep are more susceptible to fly attack than are healthy animals; hence, any measures which tend to restore such sheep to a normal condition are of distinct advantage. It might be emphasized that any circumstances which set up diarrhoea favour fly attack through the greater likelihood of fouling the wool and causing it to become attractive to the fly.

It is important that the biology of the various blowflies, especially the larval stages and the breeding habits should be known, as such knowledge may indicate a vulnerable point of attack. It is known that all blowflies which attack sheep, normally breed in decomposing animal matter, though some of them can be induced to breed in decomposing vegetation also (*e.g.*, the writer has bred the common *Anastellorhina* flies by transferring the young larvae from meat to horse manure), but the latter material is not visited by such flies for breeding purposes. The writer agrees with Froggatt in insisting that the most important measure against blowflies is the systematic destruction of all carrion, offal, or animal *debris* which are the normal breeding places of such flies. It is the only way to strike at the root of the problem. Such destruction may be brought about by burning or by thorough poisoning, as well as by encouraging the propagation of insectivorous birds (Froggatt and Froggatt, 1914, p. 753).

It has been asserted that the wholesale poisoning of rabbits by means of poison carts, poisoning water supplies, etc., and of dingoes and wild dogs by poisoned baits, has been responsible for the enormous increase in the blowfly population; firstly, by affording additional breeding places; and secondly, by causing heavy mortality amongst insectivorous birds, lizards, etc., through feeding on poisoned material. This view is not supported by McLeod and Holme (in Cooper, 1913, p. 55).

A certain amount of information regarding the duration of the various stages (egg, larva, pupa) of the chief blowflies was published from time to time by Froggatt and Froggatt, while detailed systematic observations were carried out in Brisbane in my laboratory, and in addition the longevity of adults in captivity was ascertained (Johnston, 1921, 1922; Johnston and Tiegs, 1922; Johnston and Hardy, 1923). In the present paper it is not necessary to repeat the information published therein. J. L. Froggatt (1918) has given an account of the spiracles of the larvae of the six main sheep maggot-flies.

It is highly important for the pastoralist to know how far blowflies may travel, as indicating the possible source of infestation. No data have been published regarding Australian experience, but the writer has summarized the results of Bishopp and Laake's work in Texas, which showed that species of some of the genera to which certain Australian blowflies belong, are able to fly, at least, eight miles, even up to 10 miles, within two days (Johnston, 1922, p. 275).

Trapping of flies has been widely advocated and figures of traps have been published by Froggatt, but Russell (Editor, 1921, p. 251) regarded it as being

of little value when compared with the cost of attending to the traps. Bishopp (Farmers' Bull. 734, U.S.D.A., 1919) stated that "there is a general tendency for those engaged in combating flies to put too much dependence on the fly trap as a means of abating the nuisance. It should be borne in mind that fly trapping is only supplementary to other methods of control, most notable of which is the prevention of breeding either by completely disposing of breeding places, or by treating the breeding material with chemicals."

Some birds are known to catch and kill adult flies, as also do certain fossorial wasps known popularly as "policeman flies." Froggatt reported that *Stizus turneri, Stizus* sp., and *Nysson* sp., were known to act in this way (1917). Mr. Hacker, of the Queensland Museum, has informed me that the wasps *Sericophorus chalybaeus* and *S. relucens* are known to catch sheep maggot-flies in South Australia and Queensland, respectively. He also stated that the latter wasp was probably that referred to by Froggatt (1915, p. 39) as *Gorytes* sp. However, these active wasps are not numerous and seem to exert little influence on fly investation. In Britain the dung fly *Scatophaga stercoraria* has been reported by Lefroy to be a predator on blowflies, but its value as a controlling agent is doubted by Austen (Ann. Mag. Nat. Hist., 8 (43), 1921, p. 118).

We may now briefly consider the possible biological control of the fly problem by utilizing the parasites of, and predators on, the maggot and pupal stages. Amongst the predators on larvae one might mention insectivorous birds, various ants, including the small red ant *Pheidole megacephala,* as well as Staphylinid *(Creophilus)* Histerid and Carabid beetles and even mice. Pupa are found to be preyed upon by the larval stage of a small species of Histerid *(Saprinus* sp.) in Brisbane. It is, however, from parasitic wasps that better results are hoped for. Quite a number are known to occur in Australia, the following having been reported as attacking the maggot stage and destroying the fly while in the pupal condition:—*Australencyrtus giraulti,* Johnston and Tiegs (perhaps better known as *Tachinaephagus giraulti*[1]); *Hemilexomyia abrupta,* Dodd; *Chalcis calliphorae,* Froggatt; and probably *C. dipterophaga,* Girault and Dodd. Of these, all but the first-named are rare and apparently of little value. *A. giraulti* has been studied by Johnston and Tiegs (1921, pp. 107-110), but very little is known regarding the life history of the others.

Of those which are known to parasitise the pupal stage, the most important is *Nasonia brevicornis,* G. and S. (probably more correctly known as *N. abnormis,* Boh.), others being *Spalangia muscidarum,* Rchdsn.; *Dirhinus sarcophagae,* Froggatt; and *Paraspilomicrus froggatti,* Jnstn. and Tiegs. *Nasonia* has been widely used against the blowfly in sheep country in Eastern Australia, especially in New South Wales, being distributed from Mr. Froggatt's laboratory. The habits of this insect have been studied by him and his colleagues, J. L. Froggatt and McCarthy (1914, 1915, 1916, 1917, 1918, 1922), as well as by myself and Tiegs (1921, 1922). The biology of the remaining three has also been investigated in my laboratory (Johnston and Bancroft, 1920; Johnston and Tiegs, 1922, a, b). Of all the parasitic wasps, mentioned above, only two seem to be likely to have any serious effect on blowfly increase, *viz., Australencytus* and *Nasonia.* The former has not been tried out in the field, while in regard to the latter there is considerable diversity of opinion as to its utility, the question having been discussed in some detail by Johnston and Tiegs (1922, a, b). *Nasonia* will readily parasitise practically all available pupae, but is unable to penetrate even half an inch of soil in order to reach them; hence its attacks are limited to such pupae as occur in readily accessible situations.

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(1) Mr. A. A. Girault has informed me that *Australencyrtus* is a synonym of *Tachinaephagus.* The species has been figured by Froggatt (1922) as *Stenosterys fulvoventralis,* Dodd.

The last question to be considered is the possibility of applying to sheep some medicament containing a poison with the twofold aim of (1) destroying any maggots which may be present, and (2) so poisoning the wool that it will either no longer attract flies, or else will poison any larvae which may hatch from eggs subsequently deposited. None of these, however, can control the blowfly, though they may be the means of preventing the insects from attacking sheep. Even when found to be effective for a limited time, the procedure has to be periodically repeated. The use of some repellent or poison is to be looked on only as a method for saving the sheep. Graybill, Phelps, and Stevenson[2] have published certain data relating to this subject, but the information is not applicable to the Australian problem. Cooper and Walling[3] carried out experiments with a large number of chemical substances in order to test their value against blowflies or their larvae. The following were found, under laboratory conditions, to be repellent to the adult insect (and therefore protective), when applied, diluted with precipitated chalk, to pieces of meat exposed for 17 days in England:—Methyl salicylate, p-nitraniline, picric acid, creosote, green oil, boracic acid, fusel oil, pine oil, alizarine oil, origanum oil, mustard oil, sod oil, iodoform, dimethylamine, quinoline, allyl alcohol, aloin, saponin, copper carbonate, nitrobenzine, sinapis oil, and aniseed oil. The substances applied in powder form (by using precipitated chalk as a basis) found to be most toxic to blowfly larvae were arsenic sulphide, nitrobenzine, eucalyptus oil, methyl salicylate, cedarwood oil, p-nitraniline, B-naphthylamine, oxalic acid, borax, quinoline, allyl alcohol, picric acid, dimethylamine, copper carbonate, oil of cloves, turpentine, B-naphthol, creosote, fusel oil, sinapis oil, aniseed oil, and iodoform. It need hardly be pointed out that expense would prevent many of these from being used. Some would probably detrimentally affect the wool, while others would be too readily removed by rain.

Work was undertaken in New South Wales and Queensland for many years with a view to determining what dips and dressings might be satisfactorily used. J. L. Froggatt carried out a number of experiments with certain substances—phenols, cresols, pyridine, resin, turpentine, copper sulphate, iodoform, eucalyptus oil, sulphur, pyrethum, various mineral oils, fish oils, and arsenic. The effect of many proprietary dip fluids on maggots was tested, and it was reported that in most cases not more than 50 per cent. of the maggots were killed after one hour's immersion in them. He did not make any recommendation (1916). A summary of his earlier work was given by his father in 1915 (see also Froggatt and Froggatt, 1917, pp. 15-19). The following three mixtures were recommended later (Froggatt and Froggatt, 1918, p. 14) as suitable for swabbing infested areas:—Spirits of tar and kerosene, 1:3; arsenite of soda, 1½ lb. in 50 gallons of water; castor oil and turpentine, 1:5 (rather expensive); while in regard to copper sulphate solution it was stated that though it deodorised wool and thus prevented reinfestation, it stained the wool and affected the skin. In 1920 McDougall gave an account of some spraying experiments at Trangie, New South Wales. The following swabbing fluid was ultimately recommended by Froggatt (1922, p. 104):—Water, 25 gallons; oil, 20 gallons; soap, 10 lbs.; arsenite of soda, 1¼ lb. (or arsenic 1 lb. and caustic soda 3 ozs.).

A brief survey of Queensland experience in regard to treating sheep may now be given. Cory (1913, p. 8) recommended, amongst other measures,

(2) Graybill, H. W., Repellents for protecting Animals from the Attacks of Flies, Bull. 131, U.S.D.A., 1914. Phelps, E. B., and Stevenson, A. F., Experimental Studies with Muscicides and other Fly-destroying Agencies, Bull. 108, Hyg. Lab. U.S. Public Health Service, 1917.

(3) Cooper, A. F., and Walling, W. A., The effect of various Chemicals on Blowfly, Ann. Appl. Biol., 2, 1915, pp. 166-182.

thorough crutching, the swabbing or dipping of infested hind-quarters in copper sulphate solution, and "shower dipping" of sheep with two months' wool in an arsenical dip. A series of experiments was carried out at Gindie, in Central Queensland, in 1914, when it was found that no dip or dressing was effective unless it was poisonous, and even then it afforded protection from fly attack for only a short time. The effect of applying a strong jet of arsenical fluid under considerable pressure was also tried and experiments along this line were subsequently continued by Messrs. Brown and Russell at Dalmally, near Roma, the work being carried out for the Institute of Science and Industry. Besides "jetting," the result of using "shower dip" (*i.e.*, applying the dip fluid in such a way that it falls like rain on the imprisoned sheep), and ordinary dips (where the sheep are forced to swim through and are actually fully immersed in a narrow trough or bath containing the arsenical fluid), was carefully noted (see Brown, 1919; R. S. C., 1922). Details of the method have been published (R. S. C., 1922). Most of the available proprietary specifics were tried out, using varying strengths, and it was found that ordinary arsenite of soda solution was not only very much cheaper but more easily applied and gave better protection against fly attacks, as well as being harmless to the sheep and the quality of the wool.

In "jetting," a steady pressure of from 60 to 200 lbs. per square inch, according to the amount and density of the wool (4 to 6 months' wool, 100 to 125 lbs. pressure; full fleece, 200 lbs. pressure) was made use of, about 1½ pints of the fluid being the average required for the treatment of each sheep as they passed singly through a narrow race when the jet was directed against the breech. Up to 3,000 sheep per day could be so treated by four men, and the cost per animal treated was found to be one-fifth penny. In ordinary weather 0·7 per cent. solution gave three or more months' protection besides destroying any maggots already present, but in wet weather the arsenic may be removed more quickly, and hence the process may need to be repeated more frequently. It was found that jetting with a solution containing 1·5 per cent. arsenic did not affect a small experimental flock, while thousands were treated with 1 per cent. solution without a single instance of any baneful result. If sheep were treated by jetting with a 0·7 per cent. solution three times a year the cost would be only three-fifths penny per sheep. In the case of pregnant ewes, it was recommended that if flies be not attacking, jetting should be carried out as near lambing time as possible, but for other sheep the solution should be applied when flies begin to attack. Even in the case of animals with skin injuries resulting from maggot infestation, no losses were caused through the jetting process.

The "shower" dip fluid contained about 0·23 per cent. arsenic, and animals were subject to it for from 7 to 10 minutes (=8-inch rainfall), when the fleece became thoroughly wetted. In the "swim dips" it was found that 0·2 per cent. arsenical solution destroyed lice and other ectoparasites, but was of little use as a protection against fly. Strengths up to 0·5 per cent. were used without ill effects being noticed either on the sheep or the wool. For ewes in lamb, weak sheep, and those with 6 or more months' wool, shower dipping rather than "swim dipping" was recommended, but for dry sheep and those with little growth of wool, the swim dip was preferred, as it required less time to obtain the result.

"As over 90 per cent. of the fly attack is on the breech, jetting is, as a rule, the best method of protection, as it is cheaper and a stronger solution can be used over the whole body. In the comparatively few cases, however, where other parts of the body are attacked, jetting is obviously useless, and resort

must be had to the dip; the dip also being necessary to exterminate other external parasites. So far there have been no losses from arsenical poisoning. When the sheep are dipped they should not be overheated; not dipped after midday in winter, and not after 4 p.m. in summer. They should not be driven immediately after dipping. Strict attention to these important points means that losses are practically nil" (R. S. C., 1922). There is no need to crutch after these various methods of treatment.

These results, based on experiments with thousands of sheep, must carry weight, in spite of the fact that they are opposed to the statements of the New South Wales investigators. Froggatt and Froggatt reported against the frequent spraying and dipping of sheep with arsenical solution of excessive strength on account of the danger of arsenical poisoning, and stated that though a spray containing 1½ lb. arsenite of soda in 16 gallons of water may be used as a surface application, not more than 1½ lb. in 50 gallons of water should be used if intended to reach the skin (1917, p. 20). The latter would mean only 0.3 per cent. arsenite of soda and a much lower percentage of arsenic. In a later article (1918, p. 14) they recommended the former strength (*i.e.*, nearly 1 per cent. arsenite solution) for use when jetting, and mentioned that about three weeks was the longest period for which the best proprietary specific retained any protective value. A little later, Froggatt (1922, pp. 14, 19) stated that jetting (at Warrah, New South Wales) at a pressure of about 125 lbs. cost one half-penny per sheep, the solution containing 1 lb. arsenic in 40 gallons water (*i.e.*, .25 per cent. arsenic).

Mr. Froggatt's contentions were traversed in the Brisbane Press (1922) by Messrs. Russell and W. G. Brown, who reiterated the results reported above relating to experimental work at Dalmally.

The writer would like to suggest that the arsenical treatment, by whatever method, may owe its efficacy as a protection against fly to the fact that the poison destroys the bacteria present in the soiled or damp wool or in the sores, and thus may render such treated parts quite unfavourable as sources of food supply for any larvae which may be deposited. Besides, the fact that the putrefactive and other organisms are killed, causes a cessation in the production of those odours which have a chemotropic influence on the female blowfly—thus not only is the attractive influence more or less destroyed for the time being, but also any eggs or larvae which may reach such wool, encounter a powerful contact poison, and, besides, are in a material in which the organisms that appear to be necessary to produce conditions favourable to the fly larvae, have been more or less destroyed, so that starvation may result.

It is known that some insects, including flies, are attracted to certain plants, and it was suggested that members of the genus *Stapelia* (natives of South Africa) might be grown in expectation that blowflies would be misled by the carrion-like odour of the flowers of such plants and deposit eggs on them, such eggs or larvae resulting from them perishing. Froggatt (1915, p. 42) communicated with the South African entomologist who reported adversely and pointed out that South Africa enjoyed no special immunity from blowfly, though Stapelias were native plants there.

In the Kew Bulletin (No. 10, 1922; Nature, February 10, 1922) Stapf reported that a Brazilian "stink grass" (*Melinis minutiflora inermis*) possessed an oil with insect-repelling qualities, and thought it might be introduced into the tsetse-fly belt in Africa to act as a food for cattle and as a fly repellent. He referred to its attempted introduction into Australia (Kew Bulletin, 1900), but no further information was available regarding it there. The writer is not aware of the plant having been utilized against blowfly in the Commonwealth.

Summary.

The writer agrees with Froggatt (1922, p. 20) that the solution of the Australian sheep maggot-fly problem lies in the destruction of the fly before it has had an opportunity to deposit eggs or larvae on living sheep. Extermination cannot be hoped for, but fly control is not only a possibility but a necessity under present conditions of sheep raising.

Fly control can be most successfully established by systematic destruction (by burning or poisoning) of carcases and carrion. Co-operation amongst sheep owners is essential, as neglect on one sheep-raising property may easily lead to infestation in a neighbouring "station" as well, since it is known that blowflies can travel with, against, and across the wind for many miles in a very short time.

Of secondary importance as a means of controlling flies is the utilization of traps for the adult insects and of various chalcids which attack either the larval or pupal stages of such flies. Published evidence in regard to the value of *Nasonia* in this connection is rather conflicting.

The preservation of insectivorous and carrion-feeding birds is highly desirable.

Experimental work in Queensland has demonstrated the value of applications to the sheep of strong arsenical solutions as a means for destroying any maggots and other external parasites already present, and for affording a very marked measure of protection for periods of from six weeks to three months, such application being made especially in the form of "jetting," or else in the form of showering, dipping, or swabbing. Such treatment may be accompanied by crutching in order to clear away the "dags" and soiled wool.

It is suggested that bacterial activity may be the prime factor in inducing blowfly attack, and that the arsenical treatment may owe its protective efficacy to its bactericidal action.

It may be advisable for sheep breeders to dispense with wrinkled sheep, as they are most liable to infestation. It may be necessary to breed a type of animal carrying very little wool on the breech. It is well known that crossbreds are less liable to infestation than are merinos.

A change in the time of shearing may be advantageous in order that the sheep may not carry a heavy fleece during the season when fly attack is most likely, *i.e.*, during autumn and spring.

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AUSTRALIAN COLEOPTERA.—Part IV.

By ALBERT H. ELSTON, F.E.S.

[Read August 9, 1923.]

PLATE XV.

COLYDIIDAE.

Deretaphrus bucculentus, n. sp.

Pl. xv., fig. 1.

Subopaque, reddish-brown, elytra slightly paler, antennae and legs reddish; under-surface same colour as above, in parts diluted with red.

Head subtriangular, eyes entirely concealed from above, with a round, moderately deep depression between antennae, and with dense, comparatively large punctures. Antennae robust, reaching to about the first third of the prothorax, the first joint large and globular, the remainder very compact, the last three dilated and forming a club. *Prothorax* distinctly wider than head, longer than wide, the apex wider than the base, the lateral margins in front curved outwards, and incurved to base, the anterior angles obtuse, the posterior ones acute, almost imperceptibly depressed longitudinally in the middle; densely punctured, the punctures somewhat larger than those on head, and in places confluent. *Elytra* wider than prothorax and about two and a half times as long, sides parallel to beyond the middle, then gradually rounded towards apex, base between scutellum and humeral angles carinate; punctate-striate, the punctures somewhat smaller and less distinct than those on prothorax, the first interstice wide and flat, the remainder carinate. *Scutellum* small and circular. *Under-surface* with large, regularly placed punctures, on abdomen more or less arranged in transverse rows, those on fourth and fifth segments more compact. *Legs* robust, anterior and intermediate tibiae provided on the outside with four to five small teeth, the posterior ones with only two small teeth near the apex, and all the tibiae, on the outside, furnished with a large apical spur, and on the inside, with a free spur resembling a stout bristle. Length, 8 5 mm.

Hab.—South Australia: Murray River (A. H. Elston). Type (unique), in author's collection.

This species is readily distinguished from all previously described ones by the peculiar structure of the head, the basal angles of which entirely conceal the eyes when viewed from above. On the elytra the second and fourth interstices are more strongly carinated than the remainder.

CLERIDAE.

Orthrius duplopunctatus, n. sp.

Pl. xv., fig. 2.

Fuscous; head and prothorax, in the greater part, ferruginous; palpi (in parts infuscated), spot on each shoulder, submedian curved fascia on each elytron, and under-surface of tarsi testaceous. Thickly clothed with depressed white hairs, longer and of a shaggy appearance at sides of prothorax and on legs. Under-surface latericeous to testaceous, part of abdomen slightly infuscated. Lightly clothed with pale semi-depressed hairs.

Head with a small depression near the base of each antenna; the punctures barely discernible and scattered. Antennae reaching beyond base of prothorax, second joint the smallest, ninth to eleventh forming a loose club, the eleventh ovate-acuminate, with the inside lightly emarginated. Prothorax not much longer than wide, sides roundly dilated near the middle, before apex with a curved, moderately deep, transverse impression, and with a straight one at the base. Very finely and sparsely punctured, the punctures somewhat more distinct near the apex than elsewhere, the sides at the middle with a few, more or less distinct, transverse wrinkles. *Elytra* wider than prothorax and not quite three times as long, sides subparallel to beyond the middle, then gently rounded off towards apex. The punctures small, but distinct, arranged in double rows, less distinct in the posterior half than in the forepart, the alternate interstices slightly raised. *Under-surface* lightly punctured; on the abdomen the punctures are placed, more or less, in transverse rows. Posterior *legs* longer and more slender than the anterior and intermediate ones. Length, 8 5 mm.

Hab.—Queensland: Brisbane (H. Pottinger). Type (unique), in author's collection.

The dark portion of the head is represented by a round, fuscous spot on the top, midway between the eyes, and is joined to the dark apex of the prothorax, the latter having also three dark spots near its lateral margins. The submedian fasciae on the elytra are narrowly infuscated at the suture. The peculiar sculpture of the elytra should make this species easily recognizable; it is closely covered with large, somewhat shallow, reticulate punctures, with the interstices longitudinally slightly carinate; and in each of these depressions are placed two smaller ones, side by side, which give the elytra the appearance of having double rows of small punctures, with the alternate interstices carinate. This species differs from the description of *O. cylindricus*, Gorh., by not having the head thickly and coarsely punctured, the prothorax only lightly punctured, not at all granulose, and without a pale subapical macula.

ORTHRIUS TRICOLOR, Schenk.

A specimen from Sydney, New South Wales, differs from the author's description by having the labrum, and all the tibiae at the apex, testaceous; and with a small, irregularly-shaped, black macula on the top of the head, midway between the eyes.

THANASIMOMORPHA.

Mr. Edward A. Chapin, of the Bureau of Animal Industry, Washington, has pointed out to me that the insect determined by Blackburn as *Thanasimomorpha bipartita*, Blanch., is not the species Blanchard described from Guam; with this opinion I quite concur.

Gorham remarked (Cist. Ent., ii., p. 62) that *Tillus bipartitus*, Blanch. (which was subsequently pointed out by Lesne as being a synonym of *T. notatus*, Klug), did not belong to the Tillides, and that it resembled a *Thanasimus*. Blackburn observed this and (Trans. Roy. Soc. S. Austr., 1891, p. 303) proposed the new genus *Thanasimomorpha*, with *bipartita*, as the type of it. This insect is conspecific with his *intricata* (pl. xv., fig. 3), which he added to the above genus in the same paper that he proposed the new generic name. As the genus *Thanasimomorpha* was, apparently, founded as much upon *intricata* as the insect determined as *bipartita*, Blanch., I consider, in the absence of any definite ruling on this particular point by the International Code, that Blackburn's name for the genus should stand, with *intricata*, Blackb., as its type, and *bipartita*, Blackb. (*nec* Blanch.), as a variety of the above.

Oodontophlogistus, n. gen.

Body elongate, moderately convex. *Head* comparatively small, in front of the eyes narrow and elongated. Eyes large, salient, very finely granulated, and only slightly emarginated in front. Mandibles robust, curved inwards, before apex with a conspicuous tooth, and with a smaller one below that. Maxillary and labial palpi rather long, the apical joint of each is similar in shape and size, elongated, and gradually dilated towards apex, which is obliquely truncated. Antennae reaching to about the middle of prothorax, joint 1 large and almost globular, 2 shorter and not as wide, 3 to 8 small and compact, 9 to 11 forming a loose club. *Prothorax* transverse, upper-surface more or less uneven, sides near middle roundly dilated, anterior margin somewhat narrower than the posterior one. *Elytra* subparallel and gradually rounded towards apex; with ten rows of punctures on each elytron, which is truncated at each apex, and sometimes acuminate at the apical sutural angle. *Legs* moderately robust, posterior thighs not reaching apex of abdomen. Tarsi long and slender, joints not laminate, claw joint the longest; anterior and intermediate tarsi with only four visible joints, the posterior with five, the first of which is small, but nevertheless can be distinguished. Claws robust and bifid.

This generic name is proposed for two species formerly placed by me in *Phlogistus,* namely, *rubriventris* and *ungulatus.* After the descriptions of the above species had been published a number of unmounted specimens of the latter species was received from Mr. J. Clark, Western Australia, and, on examining these, it was evident that they could not be associated with those insects which are referred to *Phlogistus,* although, in general appearance, they are somewhat similar.

TROGODENDRON AUROTOMENTOSUM, Schenk.

A specimen from South Perth, Western Australia, differs from the author's description in being smaller; bluish-black; and the oblique, median fasciae on the elytra ivory-white.

ELEALE.

In my introduction to the above genus, published in the Transactions of this Society in 1921, the opinion was expressed that *E. advena,* Chev., and *E. pantomelas,* Boisd., had been incorrectly assigned to this genus. Mr. Edward A. Chapin has recently written to inform me that the former is beyond doubt an *Epiclines.* The latter species, the type of which is in the Museum d'Histoire Naturelle de Paris, was examined by Lesne and said to be a true Eleale.(1)

Lemidia trimaculata, n. sp.

Pl. xv., fig. 4.

Nitid; red, in parts paler, almost latericeous; palpi and joints 3 to 11 of the antennae more or less infuscated; eyes, labrum, mandibles, scutellum, three maculae on elytra (one median and two subapical), narrow margin at apex of elytra, and greater part of legs, black. Clothed with moderately long, straggling, blackish, interspersed with whitish, hairs. Under-surface same colour as above, with the mesosternum (which is more nitid), metasternum, and the last three segments of abdomen, black. Lightly clothed with pale straggling hairs.

Head wide, between eyes flattened, with two large, round, interocular foveae, and with a few, scattered, indistinct punctures. *Prothorax* wider than long, sides strongly rounded near the middle, contracted anteriorly and posteriorly; with deep, transverse, subapical and subbasal impressions; and with a few barely perceptible punctures. *Scutellum* almost circular. *Elytra* wider

(1) Lesne, Bull. Soc. Ent. France, 1909, p. 206.

than prothorax, and about thrice as long, sides before middle slightly contracted, behind middle perceptibly dilated, then rounded off towards apex; with rows of scarcely discernible punctures. *Under-surface* with a few scattered punctures. Length, 6 mm.

Hab.—Queensland: Crow's Nest. Type (unique), in Queensland Museum.

This species may be easily distinguished by its colour and markings; the median macula is asymmetrical, the part on the left elytron being larger than that on the right, the subapical maculae, however, are symmetrical; the ground colour of the elytra is latericeous, and the longitudinal rows of scarcely definable punctures are of a bright red; the latter colour, however, predominates, which gives the insect its reddish appearance.

DESCRIPTION OF PLATE XV.

Fig. 1. *Deretaphrus bucculentus*, n. sp.
„ 2. *Orthrius duplopunctatus*, n. sp.
„ 3. *Thanasimomorpha intricata*, Blackb.
„ 4. *Lemidia trimaculata*, n. sp.

MONOGRAPH ON THE AUSTRALIAN LEPIDOPLEURIDAE ORDER POLYPLACOPHORA, WITH A DESCRIPTION OF A NEW SPECIES.

By Edwin Ashby, F.L.S., M.B.O.U.

Plates XVI. to XIX.

[Read May 10, 1923.]

Fam. Lepidopleuridae, Pilsbry.

Genus Lepidopleurus, Risso, 1826.

Of the four genera included by Pilsbry under the family name, two only are found in Australian waters (Man. Con., vol. xiv., pp, 1, 2), and one of these, *Choriplax=Microplax,* of Adams and Angas, has been shown by the writer (Trans. Roy. Soc. S. Austr., vol. xlv., 1921, Ashby) to belong to a very different family, that of the Acanthochitidae.

Thus the known Australian representatives of this family are all confined to the genus *Lepidopleurus,* Risso.

Genus Lepidopleurus, Risso, 1826.

Pilsbry *(l.c.)* gives the following characters: "Insertion plates absent. Girdle with minute, gravelly, smooth, or striated scales. Type, *L. cajetanus,* Poli." He also adopts and publishes a description of Carpenter's section *Deshayesiella,* Carp., 1878: "Girdle having delicate spines and chaffy scales. Valves curved and beaked, sutural plates and sinus as in *Lepidochiton.* Type, *L. curvatus,* Cpr."

Thiele (in Chun's Zoologica Heft., lvi., Rev. des Systems der Chitonen, pt. 1, p. 14, 1909) proposes a subgenus, *Parachiton,* with *L. acuminatus,* Thiele, from Duke of York Island as type.

Iredale, in paper on Chiton Fauna of the Kermadec Islands (Proc. Mal. Soc., vol. xi., pt. 1, March, 1914), places his new species *L. mestayerae* under Thiele's subgenus, suggesting that it be elevated to full generic rank, and proposes another subgenus, *Terenochiton,* Iredale, with *L. tropicalis,* Iredale, as type, and suggests that all the small Australian representatives of the genus *Lepidopleurus* be referred to this subgenus.

Iredale and May, in Misnamed Tasmanian Chitons (Proc. Mal. Soc., pts. 2 and 3, November, 1916, pp. 98, 99), discuss Australian representatives of this genus from Tasmania and South Australia, reaching no definite conclusion, but stating: "However, all those we have examined seem to fall into *Parachiton,* since the girdle appears to be covered with slender, glassy spikes." Personally, for the present, I am disinclined to adopt any of the suggested subgenera, but would point out that Carpenter's and Pilsbry's section *Deshayesiella,* which was published by Pilsbry *(l.c.),* seems to exhibit the characters of some of the Australian species and antedates Thiele's subgenus *Parachiton.* I find that the spicules, even more than the scales, in members of this genus, become easily detached, so much so that species that have been supposed to be bare of spicules are found on the examination of fresh, well-preserved specimens to have them present. I have already, in a previous paper, expressed doubts as to the wisdom of dividing this genus into subgenera on such a character.

My thanks are due to Mr. W. L. May, of Tasmania, and Dr. W. G. Torr, of this State, for the loan of much material without which the production of this paper would have been impossible.

The following species have been described as from Australia:—*L. inquinatus*, Reeve, 1847; *L. liratus*, Adams and Angas, 1865; *L. matthewsianus*, Bednall, 1906; *L. badius*, Hedley and Hull, 1906; *L. columnarius*, Hedley and May, 1908; *L. niger*, Torr, 1911; *L. pelagicus*, Torr, 1912; and, lastly, a form I am describing in this paper and naming *L. profundus*, Ashby, 1923.

LEPIDOPLEURUS INQUINATUS, Reeve, 1847.

(*Chiton inquinatus*, Reeve, Conch. Icon., pl. xxiii., fig. 154, May, 1847; *Ischnochiton inquinatus*, Rv. of Pilsbry, Man. Con., vol. xiv., p. 90; *Lepidopleurus inquinatus*, Rv. of Iredale, Trans. N. Z'd Inst., vol. xlviii., 1914, p. 423; auct. non *L. inquinatus*, Rv. of Sykes, Proc. Mal. Soc., vol. ii., pt. 2, July, 1896; non *L. inquinatus*, Rv. of Ashby, Proc. Roy Soc. Vict., 33 (N.S.), 1921 = ? *Lepidopleurus iredalei*, of Ashby, *l.c.*

In my paper describing the Bracebridge Wilson collection, in the National Museum of Victoria, reference was made to Iredale and May's paper (Proc. Mal. Soc., vol. xii., pts. 2 and 3, Nov., 1916); in commenting thereon it was contended that with the exception of recently-preserved, perfect specimens, the absence, or otherwise, of spicules on the girdle was not a sufficient indication for complete identification, for in this genus the spicules become detached when left long in spirit. The description and figures of Reeve's *L. inquinatus* so perfectly fitted the dredged specimens in the Wilson collection that one seemed justified in accepting Sykes' recognition of Reeve's shell in the dredged specimens in that collection.

I then separated the New Zealand shell on account of its distinctive large girdle scales; the sculpture of that form is so close to that of the Australian shells that, in the absence of the scales, they could not be separated. I therefore gave the name of *L. iredalei*, Ashby, to the New Zealand shell.

When going through the types of Polyplacophora in the British Museum, in June, 1922, in company with Mr. Tom Iredale, he pointed out to me that, in his opinion, Reeve's types of this shell were wrongfully labelled as from "Van Diemen's Land, Dr. Sinclair," and were conspecific with one of the New Zealand shells. He had come to this conclusion as the result of careful comparison with a number of specimens loaned to him by Mr. W. L. May and Dr. W. G. Torr, from Tasmania and South Australia, respectively. These specimens are now before me, and I regret they were not available for my comparison with Reeve's types while I was in the British Museum. But this is less important in face of the fact that Mr. Iredale had had ample opportunity of making such comparisons prior to my reaching London. I had with me a disarticulated spirit specimen from the Wilson collection, and the following is a copy of my notes:—"There are four specimens of Chitons on Reeve's type tablet; one is a juvenile *Ischnochiton*, probably *lincolnensis*, Ashby; one had been disarticulated by Sykes; the remaining two were compared with the Victorian specimen I had brought with me. This latter is a little deeper in sculpture than those on the tablet, but otherwise similar; on the other hand, the girdle scales on the Victorian specimen are much smaller than those of the two on the tablet, and the bases of numerous spicules are apparent on the former, whereas I cannot detect them on Reeve's specimens; although they are dirty, they certainly accord more with the New Zealand species, with which I believe them conspecific."

As before stated, in good specimens there is very little difference in the sculpture between the New Zealand shells and these dredged Australian ones, but the larger and broader scales and absence of spicules, except at the sutures on the former, easily separate the two. I am therefore concurring with Mr. Iredale's opinion that Dr. Sinclair's specimens were not from Tasmania but from New Zealand.

Iredale and May (*l.c.*, p. 99) say, "Moreover, we have two species collected on the New Zealand littoral." So while the name *L. inquinatus*, Reeve, must in future be limited to the New Zealand shell, it is not quite certain whether *L. iredale*, Ashby, is a synonym thereof or stands as the name of the second species, referred to by Iredale and May—that question must be left for future determination.

LEPIDOPLEURUS LIRATUS, Adams and Angas, 1864.

Pl. xvi., fig. 1.

(Proc. Zoolog. Soc. (Lond.), 1864, p. 192; Angas, *l.c.*, p. 187, 1865; *L. inquinatus*, Rv. of Bednall, Proc. Mal. Soc., vol. ii., pt. 4, p. 141, 1897; *L. inquinatus*, Rv. of Torr, Trans. Roy. Soc. S. Austr., vol. xxxvi., p. 141, 1912; *L. liratus*, Ad. and Ang. of Ashby, Proc. Roy. Soc Vict., 33 (N.S.), 1921.)

Introduction.—While Adams and Angas described several different chitons under the generic name *Lepidopleurus*, they do not appear to have recognized its generic characters; the species under consideration is the only one of them that properly belongs to this genus. This fact led Pilsbry to suggest that "it might be an *Ischnochiton.*"

The following is the original description:—"Shell small, elongated, convex; yellowish-brown maculated with pale brown. End valves and lateral areas concentrically, remotely sulcated, densely and minutely lirate, the lirae closely pustulose. Posterior valve elevated, lateral areas slightly elevated; median valves obtusely carinated in the middle; dorsal areas longitudinally lirate, the lirae closely pustulose. Girdle pale brown, densely covered with minute scales. Length, 8 mm.; width, 4 mm. Yorke Peninsula, South Australia, under stones at low water. Angas." Note by Author.—The girdle is clothed with flat, elongate, imbricating scales, mostly straight-sided and considerably longer than broad, which are very easily detached. From amongst these scales proceed, chiefly near the shell, long, white, cylindrical spicules, which are about four times the length of the scales; these spicules are in clusters at the sutures, elsewhere more or less scattered. The girdle is also furnished with a spiculose fringe and the underside is closely covered with flat, elongate scales. This species is a littorine form, and although never common, I have collected it at all places visited in St. Vincent Gulf, and also at Port Lincoln, and have recorded it for the State of Victoria. Dr. Torr has found it at Port McDonnell, in the South-east of this State, to St. Francis Island in the west. As this species does not appear to have been figured hitherto, one is included in the plate accompanying this.

LEPIDOPLEURUS MATTHEWSIANUS, Bednall, 1906.

Pl. xvi., figs. 5, 5a.

(Bednall, Proc. Mal. Soc., vol. vii., pt. 2, June, 1906, p. 92, pl. ix., figs. 1 1-f; Torr, Trans Roy. Soc. S. Austr., vol. xxxvi., 1912, p. 142; Papers and Proc. Roy. Soc. Tas., p. 28 =*L niger*, Torr, Trans. Roy. Soc. S. Austr., vol. xxxv., 1911.)

The writer supplied the specimens to Mr. Bednall which were used in the original description; they were from Marino, which is therefore the type locality. He found it on the occasion of his first collecting trip to that locality, in 1897, and he has since taken them at most of the localities visited in South Australia. It was because of Mr. Bednall's request that he refrained from naming this shell. *Original description:*—"Shell elongate, regularly arched; keel and lateral areas indistinct, but clearly defined when seen through a lens; jugal area absent; lateral slopes rounded. Colour greyish-white. Anterior valve closely, minutely, regularly, radially granulated throughout. Central valves similarly ornamented, the granulations running longitudinally on the dorsal area and radially on the lateral areas, the granulations by their direction defining the areas. Sutural plates small, triangular, and very distant, the jugal sinus consequently being

exceedingly wide; posterior dorsal margin straight. Posterior valve as the others, and with prominent, central, obtuse, elevated apex, the slope to the margin being slightly concave. Bednall. Length, 9 mm.; breadth, 3 5 mm. Hab., St. Vincent Gulf."

Note.—The description should have the words "and pleural" inserted, then reading, "The granulations running longitudinally on the dorsal and pleural areas." The body of this species is nearly always bright pink or red, but sometimes practically black. The shell varies from grey to rufous or dark brown.

LEPIDOPLEURUS COLUMNARIUS, Hedley and May, 1908.

Pl. xvi., figs. 3, 3 a, b.

(Hedley and May, Rec. Austr. Mus., vol. vii., No. 2, p. 123, pl. xxiv., figs. 27, 28; May and Torr, Papers and Proc. Roy. Soc. Tas., p. 28, 1912=*L. pelagicus* of Torr, Trans. Roy. Soc. S. Austr., vol. xxxvi., pp. 165, 166, pl. 5, figs. 2 a-f, 1912; Gatliff and Gabriel, Proc. Roy. Soc. Vict., vol. xxvi. (N.S.), p. 78, 1913.)

Original description:—"Valves round-backed, greatly arched, lateral areas inclined to the rest of the valve. Posterior valve with full rounded umbo. Girdle with minute, dense, imbricating scales. Colour uniform waxen. Sculpture; minute grains strung in longitudinal, radiating rows, parted by deep grooves of equal width. Going forward from the mucro additional rows are intercalated. The pleural and jugal areas together have about 50 rows. The lateral areas are differentiated by densely packed, less prominent, and disarranged grains. Length of single curled and shrivelled specimen, about 8 mm.; breadth, 3 mm."

To the above description I would add, from an examination of the Port Arthur specimen:—"Valves carinated as well as very greatly arched; lateral areas beset with radiating rows of closely-packed granules (about 20 rows in specimen before me); the posterior margin is deeply toothed, the separating grooves being diagonally turned upwards. The girdle, in addition to the scales, is furnished with slender, white spicules. For further details see notes under *L. pelagicus*, Torr. Hab.—The type with two valves was dredged by Mr. W. L. May in 100 fathoms, seven miles east of Cape Pillar, Northern Tasmania. The same gentleman dredged several valves in 80 fathoms off Schouten Island.

One almost complete specimen, girdle damaged, dredged in 70 fathoms, off Port Arthur; dredged in Bass Strait by Trawler "Endeavour"; dredged by Sir Joseph Verco, in 130 fathoms, off Cape Jaffa; and several valves, off the south-east coast of South Australia, in 300 fathoms.

From the foregoing records it will be seen that this species is essentially a very deep-water form, being found in varying depths from 420 feet to 1,800 feet.

LEPIDOPLEURUS BADIUS, Hedley and Hull, 1909.

(Hedley and Hull, Rec. Austr. Mus., vol. vii., No. 4, p. 260, pl. 73, figs. 1, 2, 1909; Ashby, Trans. Roy. Soc. S. Austr., vol. xliv, 1920, p. 283.)

Original description:—"Shell small, broad in proportion to length, rather low, rounded dorsally. Sculpture uniformly grain-striate. Colour entirely ochraceous, the valve margin sometimes rust. Anterior valve densely radially grained. Median valves narrow with a straight, posterior edge; central and jugal areas confluent, lateral areas indistinctly indicated by a slight fold. About 50 grain-rows to a valve, medially about a dozen grains are close set in a row, but wider apart from row to row, the rows longitudinal in the middle, converging at the sides, and losing their regularity on the lateral areas. Posterior valve with central, elevated apex and concave, posterior slope. Girdle beset with small chaffy scales, fringed with spicules. Interior white, sutural plates rounded, jugal sinus very broad and shallow. Insertion plates entirely absent. Length, 6 mm.; breadth, 3 5 mm. The body of the animal is a deep-red colour."

Note.—I have taken this rare *Lepidopleurus* at Marino and Cape Jervis, and Dr. Torr has recently taken it at Kangaroo Island, all in this State.

These differ from *L. matthewsianus*, Bed., in being broader, slightly carinated, granules coarser and further apart. Specimens taken in this State differ considerably from one another in system and regularity of sculpture; in some, the granules are placed quite irregularly, in others in fairly definite rows. Thus although several of them show decided differences from the paratype that was given to me by Mr. Tom Iredale, this element of variation prevents one from considering them distinct. In none of the specimens collected by myself can the animal be described as "deep-red" colour; in every case it has been buff.

Hedley and Hull record it from "Balmoral and Shark Island (Port Jackson); Long Reef, near Narrabeen, though a rare shell."

LEPIDOPLEURUS NIGER, Torr, 1911.

Pl. xvi., fig. 4.

(Trans. Roy. Soc. S. Austr., vol. xxxv., pp. 105, 106, pl. xxv., figs. 5 a-f, 1911.)

Dr. Torr has been good enough to allow me to examine the type of *L. niger*, Torr (which for some years has been misplaced), and I find it undoubtedly conspecific with *L. matthewsianus*, Bednall. Torr records that only one specimen was found "under stones, in shallow pool at Hopetoun, Western Australia," and no other member of this genus is recorded as having been found on the trip. On seeing the type specimen I noted at once that it had only 7 valves, and on turning up the figures accompanying the original description I found that it had been figured with only 7 valves, and had evidently never been disarticulated, as no sutural laminae are shown. It is one of the black-footed varieties of Bednall's shell, which, owing to the absence of one valve and the crowding of those that remain, gives the shell a very unusual appearance.

Dr. Torr, on p. 106, *l.c.*, remarks, "I had classified this as *L. matthewsianus*, Bednall, but on comparing them I found it much broader in proportion to its length, and the body of the animal, which is uniformly red in *L. matthewsianus*, is almost black in *L. niger*."

Although the foot is usually red, as before noted, I have found a good many with a practically black foot.

While the recognition of *L. niger*, Torr, as conspecific with Bednall's species, removes *L. niger* as a species from the fauna of Western Australia; Torr's find places *L. matthewsianus*, Bed., for the first time on the Fauna List of that State. And further, it is the first record of the occurrence of a member of that genus in Western Australian waters, and Dr. Torr is to be congratulated thereon.

LEPIDOPLEURUS PELAGICUS, Torr, 1912.

Pl. xvi., fig. 3b.

(Torr, Trans. Roy. Soc. S. Austr., vol. xxxvi., pp. 165, 166, pl. v., figs. 2 a-f, 1912= *L. columnarius*, Hedley and Hull, *l.c.*)

Mr. Tom Iredale, while we were together examining the types of *Polyplacophora* in the British Museum, in June last, called my attention to the differences in the descriptions of the girdle characteristics of *L. columnarius*, Hedley and May, and *L. pelagicus*, Torr, suggesting the possibility that the two species were not conspecific, as had been determined by Gatliff and Gabriel *(l.c.)*.

As before quoted, Hedley and May say of the first-named species, "Girdle with minute, dense, imbricating scales"; whereas Torr in his description of *L. pelagicus (l.c.*, p. 165) says, "Girdle leathery and spiny to the unaided eye; under 1½-inch lens it is covered with minute spicules."

An examination of the valves dredged with the type of *L. columnarius* in 100 fathoms, off Cape Pillar; of the valves dredged off the Schouten Island; and the complete specimen dredged off Port Arthur, led me to conclude that they were all conspecific with Torr's *L. pelagicus.* The girdle of the Port Arthur specimen, in which a portion is fairly well preserved, is clothed with long, flat, pointed imbricating scales very similar to those of *L. liratus,* Adams and Angas, but it is furnished also with a number of slender, white spicules, in this respect corresponding with Torr's description of the girdle of *L. pelagicus.* I wrote recently Mr. Chas. Hedley in reference to this feature, and he has re-examined the type of *L. columnarius,* and he writes to me as follows, on February 26, 1923: "The girdle of the type is much shrivelled, but looking at it again for the purpose of this letter, I should consider it to be spiculose."

It will be seen that while there is some divergence in the sculpture and angle of divergence of the various specimens examined (the former is probably due to wearing), there are not sufficient grounds for separating them into two species, the fact of the presence of spicules on the girdle of *L. columnarius* having been overlooked in the original description. Mr. Iredale had concluded that the large specimens I am describing in this paper under the name of *L. profundus* were possibly Torr's *L. pelagicus,* because of the spiculose character of the girdle; the extreme elevation of the shell of *L. columnarius* easily distinguishes that species from any other known member of this genus. I figure a photograph of one of the valves of the type of *L. pelagicus,* edge on, and also a valve of one of May's *L. columnarius* in a similar position; they will be seen to be almost identical.

Lepidopleurus, profundus, n. sp.

Pl. xvi., figs. 2, 2a.

(=*Lepidopleurus inquinatus,* Reeve of Sykes, Proc. Mal. Soc, vol. ii, pt. 2, 1896= *Lepidopleurus inquinatus,* of Reeve of Ashby, Proc. Roy. Soc. Vict., 33 (N.S.), 1921.)

Introduction.—The recognition of the New Zealand *Lepidopleurus,* as being conspecific with Reeve's type of *Chiton inquinatus,* leaves the deep-water species *(l.c.)* without either description or name. I therefore propose the name of *L. profundus,* referring to its deep-water habit as compared with its littorine relatives, *L. liratus,* Adams and Angas, and *L. inquinatus,* Reeve. The specimens referred to in the following description were indeterminately referred to by Iredale and May, in their discussion under the heading *Lepidopleurus inquinatus,* Reeve (Proc. Mal. Soc., vol. xii., pts. 2 and 3, Nov., 1916, pp. 98, 99).

General appearance and colour.—Slightly carinated, not evenly arched as in *L. matthewsianus,* Bed., and is slightly more keeled than is the case in *L. liratus,* Adams and Angas, sculptured in dorsal and pleural areas with narrow, finely granulose, longitudinal ribs, and in the lateral areas with closely packed, granulose, radial ribs of about half the width; this area is also strongly corrugated by transverse growth sulci.

The colour of the type, which has evidently been in spirit, is pale biscuit colour, but the fresh specimen from Port Arthur is Pinkish-Buff along the dorsal ridge and mottled Pinkish-Cinnamon along the sides (Ridgway's Colour Standards, pl. xxix.).

Anterior valve.—Raised, broad, decorated with closely-packed, very narrow, polished, granulose, radial ribs (about 100 in type); the granules coalesce and are less rounded than is the case of *L. liratus.*

Posterior valve.—Mucro very distinct, median, or a little behind the middle, the anterior portion decorated similarly to the dorsal and pleural areas of the median valves, the sculpture of the posterior half corresponds with that of the

anterior valve, except that in addition there are several well-defined growth sulci. The posterior slope is slightly concave but steeper than in *L. liratus*. Commonly in the latter species the mucro is more prominent, due to the posterior slope immediately behind the mucro being almost vertical and then flattening out to the girdle.

Median valves.—The dorsal and pleural areas decorated with longitudinal ribs composed of closely-packed, imbricating, flattened granules. In the dorsal area, these pectinated ribs are very close together, but, in the pleural area, they become further and further apart, until the interspaces are twice the width of the ribs, these last becomng more raised, though still keeping the appearance of closely-packed, semi-fused, polished, flattened granules; some of the ribs only traverse the area half-way, thereby leaving wider spaces between them, a feature that is also characteristic of *L. liratus*. The lateral areas are narrow, raised, decorated with radial ribs similar in character to those of the anterior valve, they number 20 odd in type; these radial ribs are crossed by concentric growth sulci (9 in type). The type is not disarticulated, but a separated valve from Victoria shows that there are no insertion plates; sutural laminae small, far apart, inside white.

Girdle.—The underside is clothed with scales, which are imbricating, long, flat, straight-sided, with rounded ends. The upperside is clothed with small, irregular, arenaceous scales, which are almost hidden in perfect specimens by a mass of short, slender, sharp-pointed, white spicules.

Measurement.—The type, which is badly curled, measures about 20×6 5 mm. The Port Arthur specimen, which is well preserved, measures 12×5 5 mm.; and one of the specimens dredged by Mr. May off Schouten Island is 16×6 5 mm.

Habitat.—The type, which has been selected because in it the girdle spicules have been well preserved, was dredged by Dr. Joseph Verco in St. Vincent Gulf, and, passing through the hands of Dr. Torr, became the property of Mr. Tom Iredale, to whom my thanks are due for presenting it to me for the purposes of this paper. Dr. Torr has also several similar shells, also dredged by Dr. Joseph Verco, but no data as to depth. Mr. W. L. May has dredged two in 15 fathoms in Geographe Strait, Schouten Island; six he dredged off the Pilot Station in D'Entrecasteaux Channel, in 9 fathoms; and Mr. E. Mawle has dredged it off Port Arthur at a similar depth; also several specimens were dredged in Victoria and are in the Bracebridge Wilson collection in the National Museum in Melbourne. May and Torr *(l.c.)*, referring to some of the specimens, say: "No specimen, to our knowledge, has been taken near the shore." All the specimens I have seen have been taken at depths varying from 54 feet to 135 feet, and I have seen none but dredged specimens.

In conclusion.—This species is easily distinguished from the New Zealand *L. inquinatus*, Reeve, by its smaller scales and very spiculose girdle; from *L. liratus*, Adams and Angas, by the sculpture in *L. profundus*, Ashby, being less granulose, and more like polished, pectinated ribs; the spicules in *L. liratus* are much coarser, longer, and fewer in number, and the girdle scales of *L. liratus* are larger and straight-sided, *L. liratus* also being consistently a littorine shell. In both species there is incipient bridging between the ribs, but it is much stronger in *L. liratus* than in *L. profundus*, although particularly regular in the latter. In the centre of each flattened granule in the sculpture of *L. profundus* occurs a black dot, which is the terminal of a sense organ which in more specialized forms of chitons is developed into what are termed eyes.

SUMMARY.

Name.	Habitat.	Distinguishing Characters.
Lepidopleurus inquinatus, Reeve	A New Zealand littorine shell not found in Australia	Spicules absent or very scanty, girdle scales comparatively large and broad
L. liratus, Adams and Angas	A littorine shell under stones at low water, recorded from South Australia and Victoria	Sculpture coarser and rougher than *L. profundus*, granules more raised and rounded, scales long and straight-sided, spicules coarser, longer, and comparatively few in number
L. profundus, Ashby	A deep-water shell only. South Australia, Tasmania, and Victoria	Granules in ribbing coalesced, flattened, and polished. Scales on girdle small, irregular; in perfect specimens, girdle covered with massed, short, slender, pointed, white spicules
L. columnarius, Hedley and May = *L. pelagicus*, Torr	A very deep-water shell. Off Cape Pillar, Schouten Island, Port Arthur, in Tasmania, Bass Strait, off south-east coast of South Australia	Shell exceptionally elevated and keeled, sculpture small and finely cut; girdle spiculose with flat, elongate scales
L. matthewsianus, Bednall = *L. niger*, Torr	A littorine shell, not rare in South Australia. One record each from Western Australia and Tasmania	Small, rounded, evenly arched; sculpture very finely granulose and regular; foot red or pink, rarely black
L. badius, Hedley and Hull ..	A littorine shell. Recorded from New South Wales and South Australia	Small, subcarinated, broad shell, usually more or less orange in colour; sculpture coarser and less regular than *L. matthewsianus;* foot in South Australia, buff

For description of Plates see pp. 242 and 243.

A REVIEW OF ISCHNOCHITON (HAPLOPLAX) SMARAGDINUS, ANGAS, 1867, AND ITS CONGENERS, TOGETHER WITH THE DESCRIPTION OF TWO NEW CHITONS FROM PAPUA.

By EDWIN ASHBY, F.L.S., M.B.O.U.

[Read June 14, 1923.]

PLATES XVI. TO XIX.

Before dealing with the *Haploplax* from Papua, for which, as well as other forms dealt with later in this paper, my thanks are due to my friend Dr. W. G. Torr, it became imperative to settle the question as to whether the shell described by Bednall and Matthews, under the name *Ischnochiton resplendens* (Proc. Mal. Soc., vol. vii., pt. 2, June, 1906), is distinct from the Sydney shell, which was described by Angas under the name *Lophyrus smaragidinus* (Proc. Zoolog. Soc., 1867, p. 115, t. 13, f. 28; *l.c.*, p. 222). Torr, in his paper on Western Australian Chitons, in 1911, treated it as a distinct species, but in his paper of the next year, considered it a colour variety of *I. smaragdinus.* Up to the present time no one has published the results of any careful examination. A reference to Bednall and Matthews' paper *(l.c.)* will show that they considered the common *Haploplax* in South Australia conspecific with the Sydney shell, and separated their species purely on colour characters and size.

While colour markings may, in some measure, be distinctive of geographic races, we are not justified in recognizing these features, unsupported by more important characters, as having any specific value.

A comparison of the extensive series in my collection from Port Jackson, New South Wales; Port Arthur and Frederick Henry Bay, south-eastern Tasmania; Penguin, north-western Tasmania; South Australia; and from Yallingup, in Western Australia, reveals some very interesting features.

Size.—In respect to size, the Sydney shell averages decidedly smaller than those from the other States; the largest from there, on my card, is 16×9 mm. Those from north-western Tasmania and South Australia are very similar in size, the largest on my cards measuring 23×13 and 20×11½ mm., respectively. In Frederick Henry Bay, in south-eastern Tasmania, and Yallingup, Western Australia, we find giant races measuring 30×17½ and 29×17 mm., respectively.

Colour markings.—A very striking colour variety occurs at Port Jackson, one in which the end valves are dark and the rest light, cream, white, or grey; and a similar varient also occurs in south-eastern Tasmania, but I am not aware of its occurring in any of the other localities named.

The beautifully-streaked form described by Bednall and Matthews under the name *H. resplendens,* seems only to occur in Victoria, South Australia, and Western Australia. The cruciform variety in all its colour variations is common to all the localities except Western Australia.

In all the localities except this latter there exists a great variation both in colour and pattern, but at Yallingup, on the west coast of the latter State, all the specimens taken are of one colour pattern, a dark variety of the streaked form named *H. resplendens.*

Dr. Torr advises me that he also only collected this form in the same locality, and the few specimens he collected on the south coast, at Albany, were similar.

Inside and form.—After disarticulating a series from the various localities, the shape and carination of the valves, the position of the mucro on the tail valve, and the shape of the sutural laminae were so similar as to need no special comment. The variation of the number of slits in the insertion plates of the two end valves is interesting but not conclusive; thus Sydney specimens showed 12-12 slits, Port Arthur 11-12, Penguin 11-12, Marino (South Australia) 10-10, Yallingup 10-9. But another from Marino showed several additional, crowded slits in the tail valve, while still maintaining the 10 in the anterior; also a large shell from Yallingup has 10-12 slits. The most that can be said is that the South Australian and the Western Australian shells both seem, when of an equal size, to have a fewer number of slits than is the case with the eastern forms.

Sculpture compared.—The Sydney shell is decorated with very shallow subtriangular pits, which are more evident in the pleural area than in the lateral; concentric growth sulci are present in the lateral areas and are continued across the pleural. The girdle is covered with polished, smooth, pebble-like scales, features that are common to the whole series referred to above. The specimens from south-eastern Tasmania are generally similar in sculpture, which is very shallow, the pitting in the pleural area is to some extent arranged in longitudinal rows, the shallow ridge between these when seen under 65 magnifications, and laterally lighted, gives the effect of longitudinal ribbing, a feature I have not noticed in the shells from Sydney, the growth sulci are present in the lateral areas but only to a very limited degree in the pleural; a juvenile from this locality, 10 mm. in length, is completely smooth except for growth sulci. The specimens from north-western Tasmania are very similar, although, possibly, the lateral area is smoother, the inner half often absolutely smooth, and the pitting in the pleural area is circular and more evenly distributed than the preceding, but still very shallow.

All the South Australian shells, whether they be the variety with delicate streaking, described as *H. resplendens*, or of any other pattern, show a distinctly deeper pitting, which is much more regular than any of the preceding, the pits in a few places are confluent, but on the whole are so regular that the ridges between, under a high power, resemble a network or honey-comb. In the shells from Yallingup, in Western Australia, this regular honey-comb pitting reaches its maximum development. In the pleural area, in both younger and older shells, the pitting is regular, deep, circular, or hexagonal, and the same character is preserved in the lateral areas, except that it is there a little confused by a limited amount of radial pitting. While some wavy growth sulci cross the lateral areas and are to a small degree seen in the pleural, they are not in evidence to anything like the extent that they are in the far-eastern forms. The scales in these western specimens are larger than in any of the preceding, but this may be partly due to their much larger size.

In conclusion.—Radial ribbing or shallow grooving in the two end valves and lateral areas is present in all Yallingup specimens, and in all medium to large specimens from South Australia, but is absent in those from New South Wales and Tasmania. I have one partial exception from the latter State, in which two of the valves are abnormal; in these, this feature is merely suggested.

The pitting in the eastern shells is more shallow, and in some parts absent altogether, and the juvenile specimens are often quite smooth, which is never the case with the western forms.

I therefore propose to recognize *H. resplendens*, of Bednall and Matthews, as a subspecies, including under this name all the varieties occurring in South Australian waters. One hardly knows what to do with the Yallingup form. It certainly exhibits a wonderful constancy in colour and pattern, and shows the distinctive sculpture of the South Australian shell in its most marked degree;

in addition, it is an exceptionally large race with larger scales than any from the other States, but in face of the limited material available it seems best, at any rate for the present, to distinguish it only by a varietal name. I therefore propose to recognize it as a variety of *H. resplendens* under the name *westernensis*.

It seems probable that the western form is the progenitor of the South Australian shell, and that the two forms, the eastern and the western, may have become intermixed in the State of Victoria, since the breaking down of the Bassian Isthmus. It is interesting to note that the megalapores, or terminals, of the sensory fibres are seen in these forms as black dots in the centres of each pit, in the shell sculpture.

Ischnochiton (Haploplax) lentiginosus, Sowerby, 1840.

(*Chiton lentiginosus*, Sow., Mag. Nat. Hist. Charlsworth, iv., (N.S.), p. 293, June, 1840; *Chiton adelaidensis*, Reeve, Conch. Icon., t. 191, f. 123, May, 1847.)

The following is the original description by Sowerby of a specimen from Newcastle, New South Wales:—"Shell oval, carinated, smooth; back elevated, lateral areas inconspicuous. Colour tawny-brown, ornamented with round blue spots. Margin minutely scaly; length, 15×9 mm."

As compared with *I. smaragdinus* or *I. resplendens*, this species is normally broader. The largest I collected at Bulli, in 1915, measures 16×11 mm. The "round blue spots" seem consistently present on all specimens, but in some the spots coalesce, forming blotches. The end valves and the lateral areas show shallow radial ribbing, which is broken, especially so in the lateral areas, by concentric growth sulci.

The median areas and the rest of the shell, in a less degree, are decorated with minute granules which are somewhat confused in their distribution.

While in the British Museum, last June, I was able to examine the types of Australian Polyplacophora in that collection, and my acknowledgments are due to Mr. Tom Iredale for much help in connection therewith. Together we examined Reeve's *Chiton adelaidensis*. My notes are as follows:—"This is *Haploplax lentiginosus*, Sowerby, without the blue spots, the whole being dirty white in colour. The scales are larger than *H. resplendens*, except the specimens from Yallingup, but are similar to *H. lentiginosus*. There is no doubt in my mind that Reeve's locality of Port Adelaide is quite a mistake. I have never taken this species in South Australia, though Mr. Iredale informed me that he had some that were alleged to have been taken by Mr. E. H. V. Matthews, near Second Valley, in this State. It will be seen that Sowerby's name antedates that of Reeve's by seven years.

Papuan Chitons.

I am indebted to my friend Dr. W. G. Torr for the opportunity of examining and describing a small collection of Chitons made by the Rev. R. Andrew, in Papua.

Acanthopleura spinigera, Sowerby, 1840.

(*Chiton spiniger*, Sow., Mag. Nat. Hist., 1840, p. 287.)

There are in the collection three large eroded specimens from Normanby Island, Papua, and one large and two juvenile specimens, in perfect order, from Misima, Papua. I do not consider these conspecific with the Australian *A. gemmata*, Blainville, for in addition to the more granulose character of the sculpture the Papuan shells have much longer, more slender, and curved spicules on the girdle. I consider them conspecific with the shell from the west coast of Sumatra referred to in my paper (Jour. and Proc. Roy. Soc. W. Austr., vol. viii., p. 31) under the name given above. The spicules on the Papuan specimens are considerably more slender and curved than the Sumatra specimen, and may, of course, be a distinct race.

Ischnoradsia papuaensis, n. sp

General appearance.—Broad, end valves equal in size and as well as the lateral areas radially ribbed, lateral areas raised, a minute granulose pattern covering the whole shell. Girdle scales large, pebbly, outer half keeled and pointed, inner half triangular and imbricating.

Colour.—Pale or worn valves are Light Greenish-Olive streaked with Mikado-Brown (Ridgway's Colour Standards, pls. xlvi. and xxix.), with often dark dorsal area and several dark spots on the posterior margin; the dark-coloured valves are green on the dorsal and lateral areas, merging into dark olive-brown towards the posterior margin.

Inside of shell.—Light greenish-olive merging into darker green, highly polished; in the median valves the sutural laminae, shallow, mostly bowed inwards in the centre. The tegmentum is infolded from the posterior margin, slits 1-1, and in one valve 2-1; the slit ray forms a very deep sinus, with highly-thickened walls, teeth of the insertion plates sharp, slightly grooved on the inside, eaves solid, articulamentum protrudes beyond the tegmentum; anterior valve 13 slits, posterior 18, sutural laminae with broad sinus similar to the median valves.

Anterior valve.—This valve is uniformly very minutely decussate; while in juvenile shells little other sculpture is to be seen. At an early stage they develop a series of flat, shallow, radial ribs, which are very broken, often continuing for some distance and then dying away, others being intercalated and taking their place; this gives the valve the appearance of being covered with dashes.

Posterior valve.—Broad and flat, mucro ill-defined, anterior of centre. The anterior margin of the tegmentum is bowed forward, the portion of valve in front of the mucro is very short longitudinally, and is decussated in a similar manner to the pleural areas of the median valves. The portion behind the mucro occupies nearly three-quarters of the valve, and is minutely decussate throughout; but, in addition, half-way down, the valve commences a series of broken, intercalated, radial ribs, similar in character to the anterior valve.

Median valves.—In the dorsal area the apex is smooth, then becoming grooved, with very minute, somewhat irregular, longitudinal grooving, this again changing, as the anterior margin is approached, into a decussated pattern, composed of evenly-distributed, minute granules. In the pleural area the upper part is longitudinally striate, similar to the dorsal, but rapidly becoming granulose. The lateral area is raised, with broad, shallow, radial ribs. On the valve before me I count 8, the sulci between are much narrower than the ribs. The whole area is decorated with minute granules like the rest of the shell. It will be seen that juvenile shells will show no radial ribbing at all, that feature being a later development.

Girdle.—The girdle is indistinctly banded with brown and light bands. The scales on the lighter portions are dark on the lower or outer half and light only on the upper, nearest the shell. The scales are quite characteristic of this genus, being large, subcarinated or keeled on the outer half, giving the appearance of being pointed, the upper half of each scale is subtriangular, flattened, and imbricating; the surface of the scale is not strictly smooth.

Measurements.—A somewhat damaged specimen measures 20×13 mm. The tegmentum only, of valves of type: anterior, 5×10; posterior, 5½×10; median, 3½×12½ mm.

Habitat.—Normanby Island, Papua.

Remarks.—I have placed this species under the genus *Ischnoradsia* because its scales are quite characteristic of members of that genus. But one was surprised to find only one slit in most of the median insertion plates, one valve only,

having two well-defined slits on one side, suggesting the possibility of specimens being found with two slits, which is usual in this genus. I note a Japanese species, *I. albrechti*, Schrenck, varies from one to three.

Ischnochiton (Haploplax) misimaensis, n. sp.

General appearance.—Elliptical, almost evenly arched, not carinated, shallow radial ribs in lateral areas and end valves; girdle clothed with polished, pebble-like scales, all of which are dark on the lower or outer side, but those in the light bands are transparent on the upperside.

Colour.—The ground colour of the upperside is Tea-Green, thickly covered with streaks and broad dashes of Mikado-Brown (Ridgway's Colour Standards, pls. xlvii. and xxix.).

Inside.—Greyish-green, very similar to the upperside, anterior valve with 13 slits in the insertion plate, irregularly placed, posterior 15 slits, sutural laminae shallow, anterior edge parallel with the tegmentum, sinus broad; median valves have 1-1 slit, sutural laminae somewhat rounded and rather large in proportion, sinus between very broad, insertion plate teeth sharp and the slits deep.

Anterior valve.—Raised, slope convex, shallow ribbing being distinguishable towards the margin, which is slightly crenate, the whole surface is decussated with minute, evenly-spaced granules. In the larger specimen it can be clearly seen that these granules are arranged in narrow, radial rows, about three of these forming the wider, flat, radial ribs, of which there are over 50 in each end valve.

Posterior valve.—Mucro a little anterior of middle, but little raised; the anterior portion occupies barely one-third of the valve, and the posterior two-thirds is defined by being raised slightly, thereby forming a diagonal ridge; the sculpture of the anterior portion is similar to the pleural areas of the median valves; the posterior two-thirds is similarly sculptured, but has, in addition, towards the outer margin, a suggestion of radial ribbing, but this in the type is so shallow as to be hardly discernible; several shallow-growth sulci are also present.

Median valves.—Evenly arched, not carinated, the dorsal area not defined, the combined dorsal and pleural areas are decussate with evenly-distributed, minute granules; several growth sulci are continued from the lateral areas, across the pleural area. The lateral areas are raised and well defined, covered with granules similar to the rest of the shell, but, in addition, crossed by two deep growth sulci and several minor ones; incipient, broad, radial sulci can be seen if the valve is held at a right angle. The large but crushed specimen *in situ* on a black stone measuring $15\frac{1}{2} \times 11$ mm. has five or six well-defined, flat, radial ribs in this area, where they are two or three times as broad as is the case in the end valves; they are noticeable, even without the aid of a pocket lens.

Girdle.—The girdle is broad banded, clothed with rather large, imbricating, polished scales, which are blackish in the dark bands and opalescent above and black below, on the outer side, in the lighter ones; this rather unusual feature is common to all the six specimens in the collection. The scales are polished, and under 65 mag. those nearest the shell are distinctly striate; the larger scales in the centre of the girdle are, under this power, partially striate, the surface of the scales is slightly rough, a subgranulose character that is not visible under a pocket lens. In *H. lentiginosus* the surface of the scales is smooth, although those immediately next the shell show some striae.

In *H. lentiginosus* the upper margin of the scales is evenly rounded, whereas in the species under review it is subtriangular. In the large damaged specimen before referred to there is a well-defined, short, girdle fringe; in *H. lentiginosus* in one or two specimens I can detect a less-developed fringe.

Measurements.—The type was not measured before disarticulation, but the largest one on the stone is 15½×11 mm., the next in size 15×9 mm., so probably the first-named is a little widened by crushing.

Habitat.—All the specimens are from Misima, Papua.

Remarks.—Although in outward appearance this species reminds one of *H. resplendens*, the sculpture being granulose instead of pitted, the more ribbed character of the end valves and the lateral areas, and the special scale features, easily separate it. It is separated from *H. lentiginosus*, to which species it is more nearly allied, by its much more regular granulose sculpture, different scale features, and absence of blue dots and its lack of carination, this last feature also separating it from all the races of *smaragdinus*.

In conclusion.—There is every probability that this *Haploplax* also occurs in North Queensland, and it is more than likely that the specimens collected at Port Molle, in that State, by Coppinger, and described by E. A. Smith (Zool., H.M.S. Alert, p. 79, 1884) as conspecific with *C. adelaidensis* of Reeve, are really this species, for his description well fits them. There is also just a possibility that Reeve's *C. adelaidensis* may have come from one of these northern localities, and, after all, not be conspecific with *H. lentiginosus*, to which species Mr. Iredale and the writer referred it in their examination of the type in the British Museum, with aid of pocket lens only.

For description of Plates see pp. 242 and 243.

NOTES ON A COLLECTION OF POLYPLACOPHORA FROM CARNARVON, WESTERN AUSTRALIA, WITH DEFINITIONS OF A NEW GENUS AND TWO NEW SPECIES.

By Edwin Ashby, F.L.S., M.B.O.U.

[Read August 9, 1923.]

Plates XVI. to XIX.

I am indebted to Mr. Worsley C. Johnston, of Western Australia, for the gift of one of the most remarkable collections, though small as to number of species, of Polyplacophora ever made on the occasion of a single brief visit.

It includes, amongst others, a small but new shell of a unique type that requires the establishment of a new genus for its reception; the rediscovery of a particularly interesting form of *Sclerochiton*, that has only been known from a single specimen, in the British Museum, and concerning which doubt has been expressed as to whether it was of Australian origin; and, finally, the rediscovery of a strange form of *Cryptoplax* that has been only known from a single minute specimen deposited in the Berlin Museum.

The collection was made on the occasion of a brief visit to Carnarvon, situated in Shark Bay, Western Australia. The entire absence of one of the commonest shells of that State, *Liolophura hirtosus*, (Peron) Blainville, of which I have specimens from as far north as the Abrolhos Islands, is characteristic of the whole collection. All except two species are apparently tropical forms. The absence of any representative of the genus *Plaxiphora* is the more remarkable, because at Dongarra, 300 miles further to the south, I found them living together with *Onithochiton scholvieni*, this latter being very numerous at Carnarvon.

Tonicia (Lucilina) delecta, Thiele, 1914.

Pl. xviii., fig. 2.

(Thiele, Fauna Sudwest Australiens, *Polyplacophora*, pp. 297, 298, 1911; Ashby, Trans. Roy. Soc. of S. Austr., vol. xlv., p. 47, pl. vii., fig. 2 a, b, c.)

Four specimens of this interesting shell were taken, and they are, I believe, the first that have been found other than on pearl shell.

As the complete shell has not hitherto been figured, I include a photograph.

Onithochiton scholvieni, Thiele, 1910.

Pl. xviii., fig. 1.

(Thiele, Rev. des Sys. der Chitonen, Zool., pt. 2, p. 99, pl. x, figs. 60, 61, 1910; Ashby, *l.c.*, p. 45.)

A very fine series of this beautiful *Onithochiton* were collected. Owing to their perfect condition they reveal features in colour and sculpture that have not before been noticed. As no figure of the complete shell has been published, I include a photograph.

Acanthopleura gemmata, Blainville, 1825.

(*Chiton gemmatus*, Blain., Dict. Sc. Nat., xxxvi., p. 544, 1825; Ashby, Journ. and Proc. Roy. Soc. W. Austr., vol. viii., p. 29, 1921.)

Half a dozen juvenile, well-preserved specimens were secured of this species. They are interesting in that the girdle in some of them is furnished with unusually long spicules.

CRYPTOPLAX MICHAELSENI, Thiele, 1911.

Mr. Johnston is to be heartily congratulated on the rediscovery of this interesting little *Cryptoplax*. Until now no Australian worker has had an opportunity of examining this species, our knowledge of it having been limited to the single, minute example in the Berlin Museum. So outwardly is it like members of the genus *Acanthochiton* that Dr. Thiele had disarticulated it before he discovered that it belonged to quite a different group. A full description will be given in another paper.

Acanthochiton bednalli, Pilsbry, var. **johnstoni**, n. var.

(Pilsbry, Proc. Acad. Nat. Sci. Phil., 1894, p. 81, pl. ii., figs. 7-11.)

Three specimens, of which the largest measures 12×6½ mm., of a very pretty *Acanthochiton* were collected at Carnarvon. In general appearance it differs from *A. bednalli*, as we know it in South Australia and Tasmania. The differences I have been able to detect do not seem to warrant the giving to it full specific rank, so I content myself, for the present, in distinguishing it under a varietal name only, and have pleasure in naming it after the finder, Mr. Johnston. I sent the three specimens to my friend, Mr. W. L. May, of Tasmania, and he fully concurs with me in thinking that, at least, the shell deserves this distinction.

DESCRIPTION.

The ground colour is white, almost porcelain-white, with a regular zigzag pattern and mottling of greenish-black. The girdle is dark, densely clothed with white spicules, the hair tufts are white, and the girdle fringe is white.

The dorsal area on valve 2, of two of the specimens, is bright pink, and on the other rufous. The sculpture seems normal except that the dorsal area is decidedly narrower than in typical *A. bednalli*, and has none of the deep, longitudinal grooving so characteristic of that species. A large portion of that area is quite smooth and polished, but possesses subcutaneous, longitudinal lining, in this respect corresponding with *A. granostriatus*. There can be detected on several of the dorsal areas, especially at the sides next the pleural area, some broken, longitudinal scratching. It is just possible, though perhaps improbable, that this feature, together with the longitudinal, subcutaneous lining, are survivals of the deep, longitudinal grooving of typical *A. bednalli*.

Dr. Thiele recorded *A. bednalli* as having been collected at Shark Bay by Drs. Michaelsen and Hartmeyer. I conclude, therefore, that it was the present form that they took; nevertheless I cannot but think, after all, this may prove a distinct species. The thoroughly tropical character of the fauna leads one to suspect that the characters of this shell rather simulate those of *A. bednalli*, than that there is any near relation.

SCLEROCHITON MILES, (Carpenter) Pilsbry, 1892.

Pl. xviii., figs. 3, a, b, c, d.

(*Chiton miles*, Carp. MS.; *Sclerochiton miles*, (Carp.) Pilsbry, Man. Con., xiv., p. 189, pl. 46, figs. 1-5, 1892; *Sclerochiton curtisianus*, Smith of Ashby, Jour. and Proc. Roy. Soc. W. Austr., vol. vii., 1921-2, p. 34; non *Chiton miles*, Pils. of Hedley, Marine Fauna Q'land, 1909; non *Sclerochiton miles*, (Carp.) of Thiele, Rev. des Sys. der Chitonen, pt. ii., p. 94.)

Amongst the chitons from Carnarvon are several with large, imbricating, girdle scales, simulating in general appearance *Sypharochiton pellis-serpentis*, which in sculpture and in the possession of eyes still more closely simulating pale forms of *Liolophura hirtosus*. In addition, the absolute absence of radial ribbing further separates it from these. On comparison with specimens in my

collection of Sclerochitons such as *S. curtisianus* and *S. imitator,* its distinction was at once apparent, in that it has large imbricating scales.

Pilsbry's description *(l.c.),* which, with his figures was prepared from drawings and MS. of Carpenter, as far as it goes, agrees with the specimens under review, with the exception that Carpenter's drawing, as reproduced, shows the scales on the girdle as widely separated, but the letterpress says "more or less separated." I then turned up my note on the examination of the type in the British Museum. It reads, "Has large, imbricating scales quite different from *Sclerochiton curtisianus,* Smith." Mr. Iredale informed me that the type was unique, and although labelled "Torres Strait" cannot be considered an Australian shell. My foregoing note quite clears up the discrepancy in the girdle as figured by Pilsbry. Possibly Carpenter's drawing was made from portions of the girdle from which many scales had broken away.

Pilsbry gives the number of slits in the insertion plate of the posterior valve as, obscurely, 9-11. In a juvenile specimen, examined by me, there is only one slit on each side. In an old eroded specimen I have disarticulated the slits are probably the same, but owing to the breaking down of the thin laminae, which in this species take the place of teeth in the insertion plate, this feature is somewhat obscure. I do not think this species is multifissate; Pilsbry's determination of this point, quite probably, was from another species.

Dr. J. Thiele figures under the name of *S. miles* portions of three specimens of Sclerochiton that were brought from Sumatra, which he considered either conspecific or closely allied to *miles.* His figures and description very well illustrate a partly-worn specimen of this species, with the exception of the character of the girdle, which, he states, is furnished with two forms of spicules in addition to the possession of scales. I cannot find the slightest trace of any such feature on any of the shells from Carnarvon, so that it is quite evident the two forms are not conspecific.

The specimen in the Western Australian Museum, No. 9336, referred to in my paper *(l.c.),* in which the whole of the sculpture had been eroded, is certainly *S. miles,* and not *S. curtisianus,* Smith, as therein suggested.

Unfortunately in disarticulating that specimen from Point Cloates, the whole of the scales were, through a mishap, lost, so their true character was overlooked.

In conclusion.—*S. miles* does not conform to the genus *Sclerochiton,* as defined by Thiele, in that it has no spicules between the scales, neither does it agree with Dr. Dall's definition of that genus in that instead of having "separated scales" they are imbricating.

It seems to combine, in itself, characters that have been gathered (shall I say?) from four different genera—*Acanthopleura, Liolophura, Sclerochiton,* and *Sypharochiton*—and must, therefore, be considered an intermediate form, indicating the close relationship of all these four genera.

The radula was not present in the specimens disarticulated, so I am unable to refer to its characters.

Habitat.—The type is in the Cuming collection in the British Museum, No. 42, but the locality stated on its tab. must be considered incorrect. The specimens in the Museum in Perth, from Point Cloates, were, I believe, collected by Mr. Tom Carter; those under review are from Carnarvon, a little further to the south. I have specimens in my collection of *S. curtisianus,* from Moreton Bay, in Queensland, and from Port Darwin, in the Northern Territory; but whether this latter is the extreme limit westward of that species must be left for future investigation. As far as our present knowledge is concerned, there are fully fifteen hundred miles of coastline separating the two species.

Sclerochiton thielei, n. sp.

(=*Sclerochiton miles* (Carpenter) of Thiele, Revis. des Syst. der Chitonen, Zool., 1910, pp. 94, 95, pl. x., figs. 16-23.)

The three specimens described and figured by Dr. Thiele *(l.c.)* were collected at Pulotikus, Benkulen, in Sumatra, by Ed. V. Martens. Dr. Thiele remarks, "This species is certainly closely related to *Sclerochiton miles,* from Torres Straits, but whether it is really identical with that species or not, cannot be concluded with any certainty from the description."

The rediscovery of Carpenter's (MS.) shell *S. miles,* makes it quite clear that although very similar in sculpture and form the characters of the girdle show it to be quite distinct.

Thiele says in reference to the Sumatra shells:—"The scales upon the upperside of the girdle are of different sizes, sometimes even 0 5 mm. broad, with converging ribs on their free ends. Between them and over the edge, there are small calcareous needles, about 80 μ long and 12 μ thick, while the fringe needles are about 150 μ long and 33 μ thick." There are no spicules between the girdle scales of *Sclerochiton miles* and no fringe spicules, showing that the two are not conspecific; the Sumatra shell conforms to Dr. Thiele's definition of the genus *Sclerochiton,* whereas *S. miles,* owing to its lack of girdle spicules, does not.

I have therefore much pleasure in naming the species described *(l.c.)* after Dr. Thiele, in recognition of the splendid work he has rendered in his production of his "Revision des Systems der Chitonen."

Family Ischnochitonidae, Pilsbry.

Sub-Family Ischnochitoninae, Pilsbry.

Genus **Lophochiton,** n. gen.

Having strong radiating ribs or flutes on both end valves; lateral areas, two radial ribs; median areas, coarsely sculptured with longitudinal ribs composed of closely-packed granules. Numerous slits in both end valves and 1-1 in median, teeth sharp, slits broad and shallow, but in no case "festooned" upwards at slits, as is the case in the genus *Callistochiton;* slits in end valves mostly opposite to the ribs, except the outer ones. A striking feature in the type species, possibly of secondary importance, is the existence on the pleural areas and on the posterior margin of all, except the tail valve, of long, finger-shaped, often coalesced granules; girdle clothed with thin, flattened, rather large, imbricating, ribbed scales.

Note.—The sculpture of the genus *Callistochiton* is simulated in the sculpture of the end valves, and lateral areas to a less degree, and also in the placing of the slits mostly opposite the ribs in the end valves. On the other hand, it corresponds with the *Ischnochitoninae,* in having sharp teeth in the insertion plate, and the entire absence of "festooning" at the slits. I think it not unlikely that Torr's highly-sculptured *Ischnochiton bednalli* may belong to this genus, and possibly *Ischnochiton pilsbryi,* Bed., as well, but I have not examined disarticulated specimens of these. Dr. Thiele points out that the correspondence of the slitting with the ribs is not constant in members of the genus *Callistochiton,* citing *C. adenensis,* Smith, as an example. I have examined specimens of that species in my collection which were given to me by Major Dupuis, and find that this is correct, as regards the end valves, the festooning in them being also suppressed; the slits in the median valves of that species are "festooned," as in typical Callistochitons.

I suggest that these features have been suppressed in the end valves of *C. adenensis,* owing to the great multiplication of the ribs, because I have noticed that where ribs bifurcate, no additional slits are formed. In *C. adenensis* the ribs have been so increased with corresponding reduction in size, that all trace of the position of the original ribs has been lost, and the upward festooning has likewise been suppressed. With the change in the sculpture in the tegmentum no room is left for the "festooning" under the eaves.

I designate *Lophochiton johnstoni,* Ashby, as the type of this new genus, the name being suggested by the fluted character of the sculpture of the end valves.

Lophochiton johnstoni, n. sp.

Pl. xvi., figs. 7 a, b, c; pl. xvii., figs. 1, 1 a, b, c, d.
Pl. xix., fig. 5.

Introduction.—Among the specimens collected at Carnarvon, by Mr. Worsley C. Johnston, is a small chiton bearing features I have observed in no other species. At first I referred it to *Callistochiton recens,* Thiele, which was collected in Useless Inlet, Shark Bay, in 1905, by Drs. Michaelsen and Hartmeyer, and described, but not figured, by Dr. J. Thiele on the Fauna of South-west Australia of 1911, p. 402.

But as the specimen from Carnarvon lacks some of the more important characters that distinguish the genus *Callistochiton,* especially the "festooning" of the slits in the insertion plates, and also possesses several most striking features that are not mentioned by Thiele, I have given it the name of *Lophochiton johnstoni,* after the gentleman to whose earnest efforts we are indebted for its discovery.

General appearance.—Broad, carinated, side slope a little curved, and valves radially ribbed, as in *Callistochiton;* lateral areas having two ribs, median areas decorated with ribs composed of longitudinal rows of granules. Girdle broad, banded, clothed with large, flat, thin, fluted, imbricating scales.

Colour.—Light Buff (pl. xv., Ridgway's Colour Standards) suffused with a pinkish tinge near the girdle, one large and two small orange spots are present on each side of the posterior margin of the anterior valve, and a similar, though darker, spot at the extreme end of the tail valve. The girdle is also light buff with darker bands.

Anterior valve.—Having fourteen rays or flutes, which give to the margin a crenate appearance, these rays are hardly perceptible on the first third of valve, so that in an extremely juvenile specimen they might be overlooked. The whole valve is covered with small, white granules; on the first third they seem to be round, but towards the girdle they increase in size and have a tendency to elongate; the posterior margin of the tegmentum is very deeply toothed, these teeth being composed of two or three elongate granules which have coalesced—this feature is most marked and probably unique. The ground colour between the granules in all valves is pinkish-buff; the outer orange spot, before referred to, is several times as large as either of the other two. Inside is white, teeth sharp, unserrated, there are 11 slits, which are broad, straight-sided, not "festooned" upwards, as in *Callistochiton,* teeth remarkably even and placed opposite the ribs, the outer ribs and one branch of a bifurcated rib have no slits opposite.

Posterior valve.—Postmedian, shallow, sloping behind mucro very gradually to the girdle. The anterior portion of this valve is decorated with white granules, those immediately in front of the mucro are round, but as the anterior edge of valve is approached they increase rapidly in length, becoming finger-like

and more or less coalesced and irregular. On the sides, corresponding with the pleural area of the median valves, these much-elongated granules are formed into longitudinal rows. The posterior half of this valve is much raised and decorated with twelve rays or flutes, of which the two anterior ones are much the strongest. The whole of this area is covered with round, white granules. *Inside.*—Transparent white, sinus broad, sutural laminae straight and parallel with tegmentum, slits 10, mostly opposite the ribs, the outer two having no corresponding slits.

Median valve.—The dorsal area is broadly wedge-shape and covered with white granules, which are small towards the apex but rapidly increase in size anteriorly and laterally, those adjoining the pleural area are long and finger-shaped; there does not seem to be any system in the arrangement of the grains in the dorsal area. The pleural area is very distinct, being decorated with bowed longitudinal rows of white granules; the five next the dorsal area composed of small, round, detached granules, whereas the outer five rows have extremely elongated, white, finger-like granules, which are more or less coalesced into high granulose ribs, which are increasingly raised as they approach the girdle. The ribs are widely spaced, but there is no indication of any bridging or net-work, so characteristic of Callistochitons. The lateral area is proportionately very narrow, composed of two very strongly-raised ribs, the anterior more raised than the posterior, with a deep sulcus between them, the whole of this area is covered with small, rounded, white granules, but towards the outer margin there are several masses of elongate, coalesced, widely-spaced, white granules, the posterior margin of these valves is irregularly toothed with very similar elongate processes with rounded ends, becoming coarser towards the girdle; the anterior margin is also toothed, many of them being double-headed. Inside transparent white, the tegmentum is folded over and in valve 2, pleated under the beak, sinus broad and edge bowed forward, sutural laminae shallow, waved inwards, edge in some is parallel with tegmentum, in others slightly rounded, slits 1-1, broad, sharp cut, straight-sided, eaves well defined, insertion extending beyond the tegmentum.

Girdle.—The girdle is very broad in proportion to the size of the shell, being 1·25 mm. in width, is clothed with flat, thin, fluted, imbricating scales, the scales are subpointed and have 6-7 grooves, the ribs between the grooves being shallow and flat. The scales are thinner than and quite distinct from those of any *Callistochiton* I have seen.

Measurement.—The dry specimen measures over all $7 \times 4\frac{1}{2}$ mm.; as the girdle is only in one part uncurled, and there measures 1·25 mm., the living animal would probably be $\frac{1}{2}$ mm. broader.

Habitat.—Carnarvon, in the extreme north of Shark Bay, Western Australia, collected by Mr. Worsley C. Johnston, to whom I am greatly indebted for the specimen.

In conclusion.—As before stated, I have had great difficulty in deciding whether this species is distinct from Thiele's *Callistochiton recens,* for, although the most unusual and striking characters present in the shell under review are not mentioned at all by Thiele, there is always the possibility of such features being undeveloped in a very juvenile specimen. But after making every allowance for the difference in the size of the two specimens, it seems impossible that these characters could have been overlooked by Thiele. I append a short *resume* of the correspondence and differences between the two descriptions. As before stated, the fact that Thiele did not figure *C. recens* has added greatly to the difficulty.

COMPARISON.

C. recens, measures 5×3 mm.	*C. johnstoni*, 7×4¼ mm.
Whitish, with pale grey and brown flecks.	Light buff, pinkish tinge; orange spots.
Side slope straight.	Side slope slightly curved.
Girdle somewhat banded.	Girdle banded.
Lateral areas closely granulated, more so still on posterior edge.	Lateral areas with two much raised, very distinct, radial ribs.
In pleural area granules clearly arranged in longitudinal rows, not closely packed in the rows.	In pleural area granules arranged in longitudinal rows, very closely packed, and becoming long and finger-like.

In both, the slits in the anterior valve correspond with the ribs, the mucro is shallow, and the posterior slope gradual in both. In *C. recens,* nothing is said about the scales, beyond that they are large and have 8-9 strong ribs, whereas the larger shell, *C. johnstoni,* has 6-7 ribs.

Pilsbry, in Man. Con., vol. xv., p. 260, places great emphasis on "the peculiar insertion teeth, which are curved upwards into the ribs as if festooned," as being one of the most important characteristics of his genus *Callistochiton.* Dr. Thiele makes no reference to this feature in his *C. recens,* but we must presume that he would hardly have placed it in that genus had such not been the case, neither does he make any mention of radial ribs in the posterior valve, nor the twin ribs of the lateral area. Further, he makes no mention of the protuberances I have called teeth, on the posterior margins of the valves, and no mention is made of the unique, finger-like, knobby granules of the pleural area and tail valve, all of which are marked features in *C. johnstoni.*

It is unfortunate that the differences have to be so largely determined upon negative data, but there is one piece of positive data available. Thiele states *(l.c.),* "We see the shell is like that described and drawn in *Callistochiton finschi* (Zool. Heft., 56, p. 86, tab. 8, figs. 57-60)." A reference to these figures shows practically no correspondence between it and the shell from Carnarvon.

For description of Plates see pp. 242 and 243.

A REVIEW OF THE AUSTRALIAN REPRESENTATIVES OF THE GENUS CRYPTOPLAX, ORDER POLYPLACOPHORA.

By Edwin Ashby, F.L.S., M.B.O.U.

[Read August 9, 1923.]

Plates XVI. to XIX.

Family Cryptoplacidae, Dall.
Genus Crytoplax, Blainville, 1818.

A group of vermiform chitons with greatly reduced valves, often widely separated, and with usually a great width of girdle, which is densely covered with spicules; having three slits in the insertion plate of the anterior valve, but no slits in any of the others.

Introduction.—The brief resumé of the Australian members of this genus given on p. 578 in the writer's paper on the Types, in the Paris Museum, needs revision, both on account of my notes on the examination of the types in the British Museum not having been referred to in the preparation of that paper, and also because of the recent discovery of Thiele's *Cryptoplax michaelseni*, at Carnarvon, in Western Australia. This latter was, for reasons stated below, somewhat imperfectly described, and has hitherto only been known from the unique specimen in the Berlin Museum. One is now able to deal with the group in a much more thorough manner. Descriptions are appended of the two forms described by Dr. Thiele, as up till now no description of these has been published in English.

Cryptoplax striatus, Lamarck, 1819.

Pl. xix., fig. 5.

(*Chitonellus striatus*, Lamarck, An. S. Vert., vi., p. 317, 1819; Ashby, Trans. Roy. Soc. S. Austr., vol. xlvi., p. 577.)

The discovery of Lamarck's type of *C. striatus* in the Paris Museum, referred to in my paper *(l.c.)*, settled the long outstanding question as to which of our known shells was *C. striatus*. The type came from Kangaroo Island, and the shell is the common one in the State of South Australia, but is distinct from the shell that has been known under the name of *C. striatus* from Sydney. It is easily distinguished from the more northern species in that, in the adult shells, the sculpture of *C. striatus* is always longitudinal, coarse, wavy ridges, and that, in the adult, the valves, after the first four, are usually more or less spaced; the girdle is densely spiculose, the spicules being long and much curved. Juvenile shells of this species are decorated with longitudinal rows of granules, which are less bead-like than is the case with the Sydney shells; this feature can be observed near the umbo in the adult. I have collected this species as far west as Venus Bay, and have specimens from Philip Island, and one adult given me by Mr. Tom Iredale, from Port Fairy, near the New South Wales border, in Victoria.

Cryptoplax striatus, Lam., var. gunni, Reeve, 1847.

(*Chitonellus gunni*, Reeve, Conch. Icon., f. 5, 1847; non *gunni*, Rv. of Ashby, *(l.c.)*, auct.)

I saw in the British Museum last year Reeve's type of this shell and noted that it was conspecific with *C. striatus*, Lam., from Tasmania and South

Australia. I believe the type was from the former State, and therefore suggest that the form noted from King Island (Ashby and Hull, Austr. Zool., vol. iii., pt. 2, March, 1923) as having shorter spicules, more widely spaced and proportionally stouter, than typical *C. striatus* from South Australia, be recognized as Reeve's var. *gunni*. In the same paper we noted that the granulose character of the juvenile shells from King Island was changed into ridges at a rather earlier stage than is common in typical specimens of *C. striatus*. I consider this variety is common to both King Island and Tasmania.

Cryptoplax striatus, Lam., var. **westernensis**, n. var.

In October, 1920, the writer collected at Rottnest, Western Australia, a single specimen of *Cryptoplax* that differs slightly from *C. striatus*. The specimen measures 35×15 mm.; valves 5, 6, 7 are slightly spaced, all are strongly beaked. I referred this specimen to *C. striatus* (Trans. Roy. Soc. S. Austr., vol. xlv., 1921, p. 45). It differs from the typical shell in that it shows no sign of the granulose sculpture of the juvenile form, and seems, from the start, to commence the coarse, longitudinal ridges, also the spicules on the girdle are both shorter and more slender than in *C. striatus* proper. It seems in some respects to be intermediate between *C. striatus* and the form with very short, hair-like spicules, which we have for so long incorrectly called *C. gunni* of Reeve, but the character of the spicules is nearer *C. striatus*. This was probably the shell from Western Australia referred to by Thiele as *C. gunni* and by Torr as *C. striatus*.

I therefore suggest that this western form be distinguished as a variety of *C. striatus* under the name of *C. westernensis*, Ashby.

Cryptoplax iredalei, n. sp.

Pl. xix., fig. 4.

Reference has been made to a *Cryptoplax* that has been referred to as *C. gunni*, Reeve, by most writers. My examination of the type, in company with Mr. Iredale, effectually disposes of that determination and leaves this Crytoplax without a name. Mr. Iredale has for some years been aware that this shell was not *C. gunni*, but until the rediscovery of Lamarck's types (before referred to) it was still an open question as to which of our known species were conspecific with Lamarck's shells. I promised to leave this species to Mr. Iredale for naming, and therefore will content myself with a short definition, sufficient for the purposes of this paper. (Note.—As more than a year has elapsed and this species seems still without a name, I propose to call it after Mr. Iredale. I had hoped prior to the reading of this paper to have received his approval of this action.)

The valves in this species may be slightly narrower and longer than *C. striatus* of the same size—the juvenile is similarly granulose in sculpture—but in what may be termed semi-adult specimens there is usually a space between the 5th and 6th valves, and in very large specimens—one before me measuring 95 mm. in length (dried)—there is a short space after the 3rd valve and a wide space after valves 4, 5, and 6.

The distinguishing character is found in the girdle, which is usually banded in very pretty shades of rich brown and grey. The spicules are very dense, but so minute and slender as to be overlooked altogether without the aid of a good pocket lens.

Habitat.—I have taken it at Port Lincoln and in many places on the Gulf of St. Vincent, and Mr. W. L. May has taken it in north-western Tasmania.

CRYPTOPLAX LAEVIS, Lamarck, 1819.

(*Chitonellus laevis*, Lam. An. Sans. Vert., vol. 7, Mollusca, Blainville, pl. 87, f. 5= *Chitonellus lamarcki*, Rochebrune, Ashby, *l.c.*)

The type was collected by Peron and Lesueur and measures 49×12 mm. In my paper, telling of its rediscovery, occurs the following note: "Nearly the whole of the surface of the shell is eroded, and the girdle is denuded of spicules except that portion commencing opposite valve 7, where the spicules are fortunately still in evidence. The spicules are very peculiar, being very widely spaced, short, blunt, and rounded, quite distinct from any species I have seen."

I suggested in the same paper that it might be conspecific with Thiele's *C. hartmeyeri*, but now, as the result of the present examination of almost, if not all, of the known members of this genus inhabiting Australia and elsewhere, I do not think it likely that the spicules in *C. hartmeyeri* can ever take the peculiar form of *C. laevis*, Lam., and therefore its identification must await further elucidation.

CRYPTOPLAX ROSTRATUS, Reeve, 1847.

Pl. xix., figs. 2, a, b, c.

(*Chitonellus rostratus*, Reeve, Conch. Icon., vol. iv., pl. i., fig 6, May, 1847, *C torresianus*, Rochebrune, Bull. Soc. Philom., Paris, p. 195, 1881; *C. torresianus*, Rochebrune, Ashby, *l.c.*, non *Chitonellus striatus*, Lam., auct.).

In my paper on the types in the Paris Museum (*l.c.*) it was shown that the Crytoplax from Sydney, that has been known by collectors as *C. striatus*, Lam , is not that species, but is conspecific with *C. torresianus* of Rochebrune. In the hurry of getting that paper completed in time for publication in last year's Transactions, I was unable to refer to my notes on the types one had examined in the British Museum. On turning them up I found that Reeve's name, *C. rostratus*, antedates that of Rochbrune by many years. The following is my note, dated June, 1922: "Reeve's type of *C. rostratus* looks like the Sydney *Cryptoplax*; probably the locality, Torres Strait, is incorrect."

The following is Reeve's description: "*Chitonellus rostratus*, Reeve. The beaked Chitonellus. The valves triangularly oblong, beaked posteriorly, smooth along the summit, grooved on either side, intermediate ridges somewhat grained, olive, dotted with light green, tegament thickly, short, villous-brown, dotted and banded with darker brown. Hab., Raines Island, Torres Strait, Cape Ince."

In conclusion.—Mr. Iredale and myself were evidently wrong in our surmise that Reeve's locality was incorrect, for Rochebrune's type of *C. torresianus* is certainly conspecific with the Sydney shell; this confirms the extension of the range of that species northwards to Torres Strait, and I have a specimen that seems to belong to this form from Twofold Bay, given to me by Mr. Iredale, so it is quite possible that *C. striatus* and this species may overlap on the Victorian border. This species is easily distinguished from *C. striatus* in that, although very similar in the very juvenile stage, *C. rostratus* carries this beaded, granulose character into the adult, which *C. striatus* does not; also the valves of *C. rostratus*, even in the fully adult shell, still touch one another. In *C. striatus* the valves, after the first 4, are more or less spaced in fully adult shells, the spicules in the northern species are slightly more slender, but this difference is but slight.

CRYPTOPLAX MICHAELSENI, Thiele, 1911.

Pl. xvi., fig. 8; pl. xix., figs. 3, a, b, c.

(Fauna Sudwest Australiens, *Polyplacophora*, Thiele, 1911, p. 404, pl. vi., figs. 11-17.)

Another important find of Mr. Worsley C. Johnston's, at Carnarvon, is that of a remarkable little *Cryptoplax*, 7 mm. in length, this species having previously

only been known from a single and probably minute specimen, also obtained in Shark Bay, and described by Dr. Thiele *(l.c.)*.

As I believe no previous description of this shell has appeared in any English publication, I give the following free translation from the German:—

"The colour of the shell is yellowish-brown with a few symmetrical dark spots, the posterior portion of each valve is rose-red, the sutural laminae are transparent, while the valves are fitted close together without any interspaces; shape of the median valves very little different from the others. Tegmentum is somewhat arched, broader than long (probably this is due to its being an extremely juvenile shell—Ashby), anteriorly fairly straight, posteriorly with a distinctly produced beak; the posterior valve is, similarly, a little broader than long, fairly flat, mucro overhangs the posterior margin; the anterior valve and lateral portion of others is distinctly sculptured with small warts. The 'tegmenta' is similar to *Acanthochites*. Anterior valve 3 slits, others none. The girdle banded brown, upper side clothed, not very closely, with larger and smaller, round-ended, longitudinally-grooved, lime spicules, $140\,\mu \times 17\,\mu$, $160\,\mu \times 13\,\mu$, and $60\,\mu$, respectively, Shark Bay." (The spicules are highly polished, the longitudinal grooving, more correctly scratching, can only be detected by use of a fairly high power. I am indebted to Dr. Tiegs for the use of his microscope in the matter of this determination.—Ashby.)

Dr. J. Thiele, in his Introduction, explains that he mistook the little animal for an *Acanthochiton* until he had disarticulated it; this will account for his giving no measurements.

I conclude, from the figures he gives of the valves, that his specimen was a very juvenile shell, much less than the 7 mm. specimen collected at Carnarvon. It is well to note that the valves of all very juvenile specimens of the members of this genus are proportionally much broader than is the case in the adult; in this respect the valves of the juveniles of most species have a great similarity.

Differences.—No doubt, for the reason stated above, Dr. Thiele gives no figure of the complete shell and ignores one of its most distinguishing characters, *viz.*, that the spicules on the girdle are adpressed, or lying close to the girdle, not erect, as is usual with other members of the genus *Cryptoplax*. I have been able to detect the three forms of spicules as figured by Thiele *(l.c.)*, but the long, finger-like, slightly-flattened, round-ended ones (f. 15, *l.c.)* are by far the most numerous, and differ from all other known *Cryptoplax*.

The sculpture of the valves consists of rows of but slightly-raised, flat, or squamose pustules, very similar to those on *Acanthochiton bednalli*, and in this respect different from any other known species. I give a photograph of the whole shell and also of the valves.

Cryptoplax hartmeyeri, Thiele, 1911.

Pl. xix., fig. 1.

(Fauna Sudwest Australiens, *Polyplacophora*, Thiele, 1911, pp. 405, 406, pl. vi., figs. 18-25; Ashby, Trans. Roy. Soc. S. Austr., vol. xlv., p. 46, 1921; *l.c.*, vol. xlvi., pp. 577, 578, 1922.)

Dr. Thiele states that he had three specimens for examination, all from Western Australia, two without any further data, and the other from Surf Point, Shark Bay. He describes the general appearance of the large specimen, 40 mm. in length, as yellowish with dark brown, richly marbled, the valves dark blackish-brown anteriorly, becoming lighter towards the posterior margin. The four anterior valves touch one another, the four posterior are separated by spaces that are greater than the length of the valves themselves. The figures of both valves and spicules are from a smaller specimen, of which no measurements or description, before disarticulation, are given. I conclude the

disarticulated specimen must be considered the type. The following is an abstract of his description, which I believe has not heretofore been published in English:—

"Anterior valve, partly eroded, confusedly granulose; valve 2, fairly narrow dorsal area, granules in lateral portion gradually merging into longitudinal ridges; in valve 3 he refers to distinct longitudinal folds in the lateral parts; valves 5 and 6 are the smallest, and the seventh distinctly larger. The posterior valve is a little pointed anteriorly and rounded posteriorly; the mucro is a little in front of the posterior margin; the smooth dorsal area is narrow, and the folds of the remaining part radial from the apex."

Notes on the specimen collected by the writer at Yallingup, Western Australia, in October, 1920:—

The specimen is 12 mm. in length, about one-quarter that of Thiele's larger shell, and therefore a little over one-sixteenth of the bulk of that specimen. In the Yallingup shell all the valves are touching, but this is to be expected; the valves of most species that are spaced in the adult are at this stage imbricating. Thiele's description, taken with the figures, well fits my specimen; but to this I would add that the granules in the anterior valve are in somewhat confused. intercalated rows, the grains are elongated like tear-drops, and placed diagonally in the rows. The sculpture of the other valves consists of longitudinal rows of semitransparent, white granules, commencing small near the dorsal area but increasing in size and elongation anteriorly and laterally. In no case can the outer row be said to coalesce into a rib, as stated by Thiele, but not shown in his figures; still the outermost granules are so crowded that one may conclude that, in older shells, this feature will come into being. The grains, although much raised, are not as rounded and bead-like as in the *Crytoplax* from Sydney. The most distinctive character of the shell is the arrangement and shape of the spicules. Thiele's figs. 23 and 24 *(l.c.)* well depict 95 per cent. of the spicules, the striae are as drawn and easily seen. Most of the spicules of the Yallingup specimen are shaped like his longer figure, but in stoutness half-way between his two figs. 23 and 24. I cannot notice the slight latteral compression noted by Thiele. The spicules (his fig. 26) are only met with in the bunches at the sutures. It should be noted that his fig. 24 is drawn upside down. In the Yallingup specimen the spicules are white and widely spaced, a feature that is not mentioned by Thiele, but is certainly a striking and distinctive character. The ground colour of my shell is horn colour, and no mottling can be seen on the girdle, but this character is quite unimportant, and may have existed only on Thiele's large specimen.

In conclusion.—The widely-spaced, short, stout, slightly-curved, and bluntly-pointed spicules separate this species at once from any of the forms with which we are familiar in Eastern Australia.

CRYPTOPLAX OCULATUS, Quoy and Gaimard, 1834.

(*Chiton oculatus*, Q. and G., Voy. Astrol., Zool., iii., p. 410, pl. 72 or 73, figs. 37, 38, 1834; *Chitonellus fasciatus*, Q. and G. of Reeve; *C. montanoi*, Rochebrune; Ashby, Trans. Roy. Soc. S. Austr., vol. xlvi., 1922.)

While this species is very close to *C. larvaeformis*, Burrows, reference to my paper *(l.c.)* will show that in this latter species only the two first valves are circular, whereas my specimen of *C. oculatus*, from Island Sula, has the three first valves broad and circular. On comparison with specimens of the former from Tonga (given me by Major Dupuis) I note that the spicules of the Sula shell are longer and quite distinct, also, as noticed by Dr. Pilsbry, the three anterior valves of *C. oculatus* are surrounded by a broad margin of longish, black spicules, with another outer ring of white; this feature is quite absent from the Tonga shells.

I therefore consider that we are justified in retaining *C. oculatus*, Q. and G., as a good species.

Description.—The sculpture of this species is composed entirely of longitudinal ridges, the first three valves are circular, broad, and imbricating; all the rest, in adult shells, are narrow and more or less spaced.

Girdle.—The girdle is handsomely banded and the spicules are dense, short, stout, and have rounded apices; in this respect it is the only species that seems to approach the spiculose character of Lamarck's *C. laevis*.

I have two juvenile specimens given to me as from Torres Strait, by Major Dupuis, that quite possibly belong to this species, but determination is difficult, as all the spicules have been lost. These are the only specimens I have seen that are strictly Australian in origin. While we were unable to locate Quoy and Gaimard's type in the Paris Museum, it is just possible that the shell described by Rochebrune, under the name *C. montanoi*, may have been their actual type, for he was not adverse to doing such, for, as I have before shown, Rochebrune certainly gave a new name to Blainville's type of *Chiton longicymba*.

CRYPTOPLAX BURROWI, Smith, 1884.

(*Chitonellus burrowi*, Smith, Zool. Coll. H.M.S. Alert, p. 85, 1884; *Chitonellus larvaeformis*, Blainville of Reeve, Conch. Icon., f. 3, 1847; *Cryptoplax burrowi*, Haddon, Chal. Polyplac., p. 42, pl. 3, f. 11 a-m; Pilsbry, Man. Con., vol. 15, p. 54, 1892.)

Quoting from Pilsbry: "This curious species is known by the small size of the valves, the remoteness from one another of the fourth, fifth, and sixth, and the excessively short and densely packed spines on the mantle." Reeve's figure is excellent, but his habitat of Port Adelaide is, of course, a myth; but the specimen recorded as having been taken at Port Molle, in Queensland, is probably authentic. I did not see this species in the collections in the British Museum, but we may have overlooked it.

SUMMARY LIST OF AUSTRALIAN CRYPTOPLAX.

I.	*Cryptoplax*	*striatus*, Lamarck. South Australia and Victoria.
Ia.	"	*striatus*, var. *gunni*, Reeve. Tasmania.
Ib.	"	*striatus*, var. *westernensis*, Ashby. Western Australia.
II.	"	*laevis*, Lamarck. Locality and identification doubtful.
III.	"	*iredalei*, Ashby. South Australia and Tasmania.
IV.	"	*rostratus*, Reeve. New South Wales and Queensland.
V.	"	*oculatus*, Quoy and Gaimard. Queensland.
VI.	"	*burrowi*, Smith. Queensland.
VII.	"	*hartmeyeri*, Thiele. Western Australia.
VIII.	"	*michaelseni*, Thiele. Western Australia.

A total of eight species and two varieties.

DESCRIPTION OF PLATES XVI. TO XIX.

All reproductions from photographs by E. Ashby.

PLATE XVI.

Fig. 1.	*Lepidopleurus*	*liratus*, Ad. and Ang. From South Australia.
" 2.	"	*profundus*, Ashby. Type. From South Australia.
" 2a.	"	*profundus*. From South Australia. Median valve, edge on.
" 3.	"	*columnarius*, Hed. and May. From Tasmania.
" 3a.	"	*columnarius*. Median valve, edge on, marked co-type.

Fig. 3b. „ *pelagicus*, Torr. Type. From South Australia.
„ 4. „ *niger*, Torr. Type. From Western Australia.
„ 5. „ *matthewsianus*, Bednall. From South Australia.
„ 5a. „ *matthewsianus*. Median valve, edge on.
„ 6. *Ischnochiton (Haploplax) misimaensis*, Ashby. Type. From Papua.
„ 6a. „ „ *misimaensis*. Type. Anterior valve.
„ 6b. „ „ *misimaensis*. Type. Median valve.
„ 6c. „ „ *misimaensis*. Type. Posterior valve.
„ 7 a, b, c. *Lophochiton johnstoni*, Ashby. Type. From Western Australia. Anterior, median, and posterior valves.
„ 8. *Cryptoplax michaelseni*, Thiele. Type. From Western Australia.

PLATE XVII.

Fig. 1. *Lophochiton johnstoni*, Ashby. Type. From Western Australia.
„ 1 a, b, c. *Lophochiton johnstoni*. Type. Anterior, median, and posterior valves.
„ 1d. *Lophochiton johnstoni*.. Type. Median valve, edge on, showing divergence and slight curvature.
„ 2a. *Ischnoradsia papuaensis*, Ashby. Type. From Papua. Anterior valve.
„ 2b. „ *papuaensis*. Type. Inside of median valve showing 2 slits.
„ 2c. „ *papuaensis*. Type. Posterior valve.
„ 3. *Sclerochiton curtisianus*, Smith. From Townsville, for comparison with fig. of *S. miles*, showing different character of girdle scales, etc.

PLATE XVIII.

Fig. 1. *Onithochiton scholvieni*, Thiele. From Carnarvon, Western Australia.
„ 2. *Tonicia (Lucilina) delecta*, Thiele. From Carnarvon, Western Australia.
„ 3. *Sclerochiton miles*, (Cpr.) Pilsbry. From Carnarvon, Western Australia. Showing sculpture and peculiar girdle scales.
„ 3 a, b, c. *Sclerochiton miles*. Same specimen. Anterior, median, and posterior valves.

PLATE XIX.

„ 1. *Cryptoplax hartmeyeri*, Thiele. From Yallingup, Western Australia.
„ 2. „ *rostratus*, Reeve. From Sydney, New South Wales.
„ 2 a, b, c. *Cryptoplax rostratus*. Juvenile. Anterior, median, and posterior valves showing shape.
„ 3. *Cryptoplax michaelseni*, Thiele. From Carnarvon, Western Australia.
„ 3 a, b, c. *Cryptoplax michaelseni*. Same specimen. Anterior, median, and posterior valves showing shape.
„ 4. *Cryptoplax iredalei*, Ashby. Type. From South Australia. Minute girdle spicules.
„ 5. „ *striatus*, Lamarck. From type locality, South Australia. Coarse girdle spicules.

ON THE ZONATION OF THE VEGETATION IN THE PORT WAKEFIELD DISTRICT, WITH SPECIAL REFERENCE TO THE SALINITY OF THE SOIL.

By Professor T. G. B. Osborn, D.Sc., and
J. G. Wood, B.Sc., Department of Botany, University of Adelaide.

[Read September 13, 1923.]

Plate XX.

This paper embodies the results of a reconnaissance visit made in March of this year to the Port Wakefield district. The object was to study the zonation of the vegetation when passing from a community of undoubted halophytes to a "saltbush" community.

Saltbush is the name given in Australia to various annual or half-shrubby perennials belonging to the Chenopodiaceae, especially to the genus *Atriplex*. The plants have characteristically grey, more or less fleshy leaves, which, as the common name implies, contain a quantity of sodium chloride. Saltbushes grow abundantly over the arid portions of Australia, and are of considerable economic importance, because they provide a reserve of fodder for the pastoral industry. In the dry season, or in times of drought, stock can live entirely on the leaves of these plants.

Because of their appreciably salt taste, these bushes have been regarded as characteristic of a soil with a high saline content, that is halophytes. The Chenopodiaceae, as a family, contains a large number of halophytes, and the Atripleces of Australia have often been regarded as belonging to this biological group of plants,[1] apparently, largely on general grounds.

Last year one of us, in company with R. S. Adamson, was led to express the opinion that in some cases, at any rate, the Australian saltbushes did not appear to be halophytic.[2] At that time we had no more positive data to offer than our observations upon the distribution of the plants in the field. Recently, when studying the vegetation of Pearson Islands,[3] it was found that a typical saltbush community, composed of *Atriplex paludosum,* was developed on soils of only average salinity (NaCl 20 per cent. of the air dry soil).

Observations on the flora of the arid portions of South Australia have been in progress in this Department for some time. It seems useful, however, to preface the accounts with a piece of field work, if only of the reconnaissance type, that should involve a direct comparison between saltbush and plants of the salt marshes, *i.e.,* true halophytes. The results, it is believed, have sufficient general interest to justify their separate publication.

TOPOGRAPHIC.

Port Wakefield stands on the eastern shore of Gulf St. Vincent, about five miles south-south-east from the head. The railway station is only 18 feet above high-tide mark, and the country north and south of the township extends as a

(1) Maiden, J. H., "Australian Vegetation," in Federal Handbook on Australia, p. 191, 1914. Cannon, W. A., "Plant Habits and Habitats in the Arid Portions of Australia," Carnegie Inst. Publ., No. 308, 1921.

(2) Adamson, R. S, and T. G. B. Osborn, "On the Ecology of the Ooldea District," Trans. Roy. Soc. S. Austr., xlvi., p. 554, 1922.

(3) Osborn, T. G. B, "Flora and Fauna of Nuyts Archipelago and the Investigator Group, No. 8, On the Ecology of Pearson Islands," Trans. Roy. Soc. S. Austr., xlvii., p. 106, 1923.

level plain, often flooded in the wet season by high tides or drainage water. The general topography is flat and uninteresting. Passing inland from a muddy, mangrove-fringed shore, one crosses a plain which varies from a few hundred yards to a mile or more in width. This is flooded by high spring tides in the wet season. It bears a flora of low shrubs, "samphires," chiefly *Arthrocnemum halocnemoides*. This plain rises very gradually to a slightly higher level that is not flooded by sea water. At this level occurs an open dwarf shrubland of bushes of *Atriplex paludosum*. Behind this again, lies low rolling country. The soil varies from a loam, which is cultivated, to a red sandy soil. The natural vegetation of this area has largely disappeared under the plough, or because of grazing animals, but on the red sand near the head of the Gulf there occur the relics of a saltbush flora, *Atriplex stipitatum* being the most important undershrub.

Gulf St. Vincent, according to Howchin,[4] is of very recent origin, and owes its existence to earth movements that are probably still in progress. In Post-Pliocene times the site of the Gulf was a wide valley which became filled with sediments. A bore at Port Wakefield shows fluviatile deposits to a thickness of 310 feet. Still more recently this valley was submerged, with the result that a shallow arm of the sea was formed. The sea bottom and shore at Port Wakefield consist of clays, overlain to a slight extent by wind-blown sands.

The position of Port Wakefield, near the head of a long shallow arm of the sea, makes the district a suitable one for the evaporation of sea water and the recovery of sodium chloride. The sea at the head of the Gulf has an abnormally high density, especially at the close of the dry summer seasoon. Recent figures from a Bulletin of the Geological Survey of South Australia show this; the salinity of some other sea waters is given for comparison:—

SALINITY PER CENT.

Ocean water mean of 77 analyses. (Challenger)[6]	Spencer Gulf, South Australia. Crystal Salt Wharf.[5]	Gulf St. Vincent, South Australia. Price, near Port Wakefield.[5]	Suez Canal, Ismailia.[6]	Mediterranean, near Carthage.[6]
3·301-3·733	5·166	4·555	5·103	3·897

Thus the water, flooding the plains around Port Wakefield, is likely to bring considerable quantities of salts with it. Some of these will be leached out in the wet season by rain, but others, especially the less soluble, will accumulate in the surface layers by evaporation. A soil of this type, rich in soluble salts and lime, was met with. (See sample 5, below.)

HABITAT FACTORS.

CLIMATIC.

The climatic conditions at Port Wakefield are those of the semi-arid portions of South Australia. The rainfall is actually low, being 12·93 inches on a mean of 42 years,[7] the highest recorded annual rainfall being 17·65 inches, in 1910; the lowest, 6·49, in 1888. The monthly distribution is shown by fig. 1. It will be seen that the summer is dry, December to February showing only just over ·5 inches of rain each.

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(4) Howchin, W., "The Evolution of the Physiographical Features of South Australia," Rept. Australasian Ass. Adv. Sci., xiv., Melbourne, p. 176, 1913.

(5) Jack, R. L., "The Salt and Gypsum Resources of South Australia," Dept. of Mines S. Austr., Bull. 8, p. 37, 1921.

(6) Clarke, F. W., "The Data of Geo-Chemistry," U.S. Geol. Sur. Bull. 695, p. 123, 1920.

(7) "Results of Rainfall Observations in South Australia," Commonwealth Meteorological Service, Melbourne, Govt. Printer, p. 339, 1918.

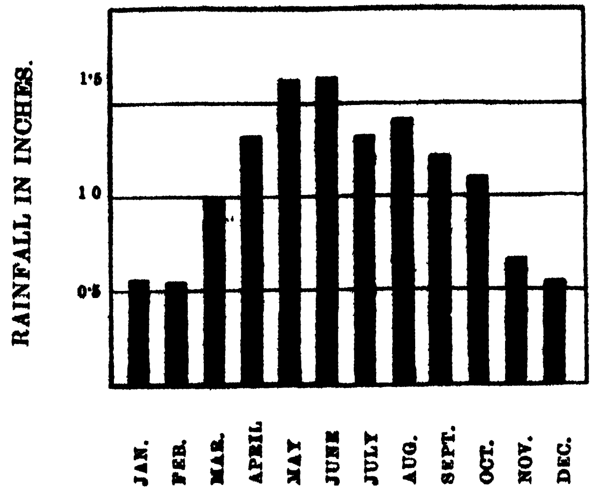

Fig. 1.
Monthly rainfall at Port Wakefield, based on records of 42 years.

The rainfall of the few months immediately before our visit is important in considering the soil analyses given below. By courtesy of the State Meteorologist we are able to give the figures for the 12 months ending March 31, 1923.

It will be seen that the two months immediately preceding our visit had been abnormally dry, and that the drought lasted throughout March, when we collected the samples. They were taken, then, at a time particularly favourable for the collection of soil samples, as the soluble salts would be about maximum concentration.

RAINFALL IN INCHES, APRIL, 1922, TO MARCH, 1923.

April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	12 Months
·75	2·01	1·69	2·21	1·69	·86	·84	·00	2·06	·13	·08	·02	12.34

The topographic position of Port Wakefield on a level plain at the head of a long narrow arm of the sea has an effect on the rainfall of the area. Though on the coast of a gulf, it is virtually inland, for it stands some 30 miles from the open sea. The moisture contents of the south-west winds, which bring a great part of the rain to this portion of South Australia, is little affected by the narrow waters at the head of the Gulf. Altitude is, therefore, an important factor in the condensation of water from the moisture-laden winds, for the rainfall decreases as one passes inland, unless altitude rises proportionately.[8] Port Wakefield lies about the centre of a little area enclosed by a 15-inch isohyet, 20 inches of rain or more being the average for the surrounding districts. To this lower rainfall may be attributed the occurrence of the *Atriplex stipitatum* area.

Temperature data are not available for Port Wakefield. It lies, however, close to the 75° F. January isotherm, but slightly to the south.

An important factor in determining the aridity of a district is the annual evaporation. Jack[9] gives a map of Australia showing the annual evaporation in inches for the evaporation stations of the Commonwealth, also the isatmics. Port Wakefield lies about midway between the 50-inch and 60-inch lines, from which we may deduce that the annual evaporation from a free water surface would be about 55 inches. Since the mean annual rainfall is only 12·93 inches,

(8) Taylor, Griffith, "The Australian Environment," Melbourne, p. 99, 1918.
(9) Jack, R. L., *loc. cit.*, p. 8.

the net annual evaporation must be somewhere in the region of 40 inches of water per annum. This will conduce to an accumulation of saline matter in soils flooded by sea water, or kept moist by seepage owing to their proximity to the sea.

EDAPHIC.

Two distinct soil types were found. The one, a red sand, was limited to a low rise behind the plain area. The other was clay mingled with shells or shell *debris*. The majority of the samples were soils of this description. In many of the samples the proportion of shell remains is very high, as is shown by the amount of lime found by analysis.

The samples were obtained at a depth of 9 to 12 inches by means of a small spade. In all cases the surface soil was first brushed away, and an excavation was made. The sample was then taken as a slice about an inch thick down a vertical side of the pit. It was then placed in an air-tight tin and conveyed to the laboratory. After air drying, the soils were passed through a 10-mesh (2·6 mm.) sieve, the portion passing through being used for the analyses. These are given in the table on page 248.

The moisture content was determined in two ways. First on the soil as collected, and again after air drying. In each case it represents the loss on heating at 110° C. until the weight was constant.

It is necessary to adopt some arbitrary basis for calculation in order to obtain comparative results from soils from different areas taken at different times. All our percentages, therefore, are taken on the soil air dry at 15° C., unless otherwise stated.

The moisture content of the moist soil shows a progressive decrease in amount following a line inland from the sea. Further, a comparison of the two moisture columns shows that in the zones furthest inland the soils were practically air dry when collected, for the moisture contents of the "moist" and "air dry" soils are nearly identical.

The total salt content runs parallel to the water content; it shows a progressive and coincident decrease in amount from the sea inland. The chlorine determinations show that the bulk of the soluble salts were chlorides. The total soluble salts are expressed in two ways; first, as a percentage of the "wet" soil as collected; and second, as a percentage of the "air dry" soil.

Soils Nos. 1 and 2, from the *Arthrocnemum arbuscula* area, show an abnormally high percentage of soluble salts. This is, no doubt, influenced by the season of the year at which they were taken, for, at the end of a long dry summer with a high evaporation rate, the seepage of sea water of hypersalinity would produce this effect.

If a curve were made expressing the decrease in salinity as one passes inland, it would show four sharp discontinuities. These correspond with the four main plant communities that one recognizes in the field, suggesting that salinity of the soil is an important factor in the distribution of the vegetation.

The remaining columns of the table give the loss on ignition, the lime content of the soils, and the soil acidity.

The organic matter and combined water, as shown by the loss on ignition, do not seem to play any great part in the distribution of the vegetation. The salt swamp of *Arthrocnemum arbuscula* is richest in organic matter. Then comes the soil of the *Atriplex paludosum* community, which is richer than either the *Arthrocnemum halocnemiodes* community, on the seaward side, or the *Atriplex stipitatum* community, further inland.

The lime content is somewhat variable, but shows on the whole a decrease in amount as one proceeds inland. The shell-island, sample No. 3, is highly calciferous, as might be expected, for it appeared to consist entirely of marine

No.	Zone.	Moisture at 110° C. in *wet* soil, as collected	Moisture at 110° C. in air dry soil	Total Soluble Salts		Cl	NaCl	Organic matter and combined water	CO_2	$CaCO_3$	pH.
				In *wet* soil as collected	In air dry soil						
1	*Arthrocnemum arbuscula* and *Salicornia australis* near to mangroves (shells and clay)	46 7	6·6	10·5	17·5	10·01	16 71	8·3	25 0	56·6	8·6
2	*Arthrocnemum arbuscula* and *Salicornia australis,* near base of "island" (shells and clay with more humus)	38·5	6·4	11·5	16·9	9·64	15·70	11·2	17·9	40·5	8·0
3	Top of shell "island" in *A. arbuscula* area (shells)	1·6	1·6	1 1	1·1	0·03	0·06	·35	40·0	90·7	8·2
4	Low shrubs of *Arthrocnemum halocnemoides*—										
	(a) Around roots	14·7	8·6	4·0	4·2	1·92	3·17	1·6	25·2	56·7	8·6
	(b) Below horizontal roots but penetrated by vertical (shells with clay)	21·8	8·6	4·3	4·9	2·30	3·77	2 9	27·0	61·4	8·4
5	Top 7 cms. of soil from same place as No. 4, *Mesem. australis* and *Frankenia* (limestone dust)	6·9	6 3	7·2	7·2	3·24	5·33	1·0	30 3	69 0	8·2
6	Rim of creek in *A. halocnemoides* community at junction with colony of *Atriplex paludosum*	8·5	4·4	2 7	2·8	0 98	1·62	4·5	22 9	52·0	8·0
7	Another part of *A. halocnemoides* zone near limit	11·8	7·4	2·8	2·9	1·40	2·30	1·5	26·4	30·8	8·5
8	*Atriplex paludosum* close to junction with *Arthroc. halocnemoides* (clay)	5·0	4·9	1·6	1·6	0·66	1·08	4·0	13·0	29·5	8·4
9	*Atriplex paludosum* near middle of zone (clay)	5·7	5·6	1·6	1·6	0·53	0·78	6·8	5·6	12·7	8·2
10	*Atriplex stipitatum* with *Lomandra,* etc. (red sand)	2·5	2·5	0·3	0·3	0·01	0·02	2·3	0·4	0·9	7·4

shells or their *debris*. The red sand, on the other hand, is a soil of entirely different origin. It contains practically no lime.

The soil acidity (pH) does not show any great variation, with the exception of soil No. 10. All the soils, with the exception of the latter, have an alkaline reaction approximating to that of sea water (pH 8 6). In soil No. 10 the effect in the decrease in the amount of salts and lime is seen. The pH value is just on the alkaline side of neutrality.

Water retaining capacity of the Soil.—It is obviously desirable to have some means of comparing the water retaining capacity of the soils. This can, of course, be expressed by the wilting coefficient,[10] but the method is unsuited to work of a reconnaissance type.

Hilgard[11] gives a method of obtaining the maximum saturation of a soil sample. We tried this method and found the results approximately the same as those obtained by the method we finally adopted. The results obtained by the following method have been found consistent and are comparable. The bottom was knocked out of a small test tube 1 5 cm. in diameter and the hole plugged with a small amount of cotton wool. Soil was then poured in to a height of about 8 cms., and the sides of the tube lightly knocked to tamp down the soil. The tubes were then allowed to stand in a Petri dish of distilled water until the water just reached the top of the soil column by capillarity, temperature and humidity remaining constant. Weighings of the tubes and contents, before and after absorption, allow the percentage of water in the soil to be calculated.

Soil sample No. 4a—Water, 50 2 per cent.
" " " 9 —Water, 46 3 per cent.
" " " 10 —Water, 36 3 per cent.

We took these three samples as representative of the three main zones discussed below; determinations of the water retaining capacity of the other soils were not made.

VEGETATION.

The vegetation may most conveniently be considered by a brief description of the different communities crossed in a transect from the coastline, passing inland, to the low sandy upland. The communities show a remarkably regular zonation.

Avicennia officinalis consociation.

Mangroves fringe the shore and come inland to the limit of daily tidal scour. The community is a closed one, and *Avicennia officinalis* is the only species. The ecotone line between the mangrove consociation and the salt swamp plants is very regular, the determining factor being the limit of regular tidal flooding. Mangroves follow the estuaries of drainage channels into the salt swamp area only so far as the tide regularly ascends.

Arthrocnemum arbuscula consocies.

The dominant species in the salt swamp country is *Arthrocnemum arbuscula*. The bushes have a rounded habit and are 1-1·5 metres high. They branch freely, and would form an impenetrable thicket, were it not for the fact that the secondary lignified tissue is curiously brittle, owing to the structure of the ground sclerenchyma. The foliage shoots are green and succulent. This was so at the time of our visit; in spite of the high percentage of soluble salts in the soil (samples Nos. 1 and 2), the plants showed no sign of a lack of

(10) Blackman, V. H., "The Wilting Coefficient of the Soil," Journ. of Ecol., ii., p. 43, 1914
(11) Hilgard, E. W., "Soils," p. 209, 1919.

water. Generally only the distal two or three internodes remain green and succulent, the more proximal portions of the shoots dry up and become thin.

Arthrocnemum arbuscula often forms a pure community, though associated with it may occur:—

Kochia oppositifolia *Suaeda australis*
Salicornia australis

The last two are prostrate half-shrubby plants; both occur most noticeably at the seaward margin of the thicket. *K. oppositifolia* is a low bushy plant, about 50 cms. high. It occurs scattered over the *Arthrocnemum arbuscula* zone.

The soil analyses (Nos. 1 and 2) show that the above plants are true salt marsh species, being able to live in a muddy soil that is constantly wet and with a high saline content. In spite of these factors the plants of this consocies appeared turgid and healthy, much more so than those of the communities further inland, which were showing the effects of the prolonged drought.

Arthrocnemum halocnemoides consocies.

A dwarf shrubland in which *Arthrocnemum halocnemoides* is the dominant occurs as an open community over the greater part of the coastal plain. The ground is flooded occasionally at high-water spring tides, but during the wet season it is frequently swampy owing to drainage.

The soils of this area are Nos. 4a and 4b, 5 and 7. Excluding for the moment No. 5, it will be seen that the moisture in the soil as collected ranged from 21·8-11·8 per cent. The total salts in the air dry samples range from 4·9-2·9 per cent., of which 3·77-2·30 per cent. is sodium chloride. The organic matter is low, while the lime, owing to shell *debris*, is high.

A. halocnemoides forms a pure community near its seaward limit. Further inland *Frankenia pauciflora* and *Mesembryanthemum australe* appear between the scattered bushes of the samphire. The surface of the soil here is light and powdery; the surface layer is analysed as No. 5. This soil, which extends to a depth of about 7 cms., was practically air dry when collected. The content of soluble salts (7·2 per cent., of which 5·33 per cent. was sodium chloride) is much higher than the underlying layers. This surface layer may be said to have its own flora of shallow-rooting plants, the *Frankenia* and *Mesembryanthemum* mentioned above. Their roots were not observed to penetrate the deeper layers, nor do the roots of *A. halocnemoides* develop in the surface layer. It is almost as if two different habitats were superposed in portions of the plain.

Arthrocnemum halocnemoides is a low shrubby perennial, here generally under 50 cms., with a free branching habit. The internodes average 2 cms. in length and remain fleshy for some distance down the shoot, so that the plant has a much greater water reserve within its tissues than has *A. arbuscula*. The old stems may attain a thickness of 3-4 cms. at the base, but have a characteristically brittle nature owing to the structure of the "secondary wood."

The root system is of interest. There is a short tap root and several lateral branches that descend nearly vertically for 18-20 cms. There they meet a stiffer clay subsoil, along which they run horizontally, branching freely. They do not penetrate the subsoil themselves, but bear at frequent intervals much thinner lateral roots. These are under 1 mm. in diameter, do not become secondarily thickened, but obviously function only for a limited time before they die. They are replaced by other roots arising close to their bases. These in turn die and are replaced, so that tufts of rootlets occur along the horizontal roots. It seems probable that this "deciduous" root production is associated with alternating periods of vegetative activity and quiescence. A somewhat similar production of

tufts of roots that have a short duration is well known in the case of other succulents, *e.g.*, in the Crassulaceae. When collected, vegetative activity on the part of *A. halocnemoides* appeared to be at a standstill, the plants were wilting, showing obviously the effect of the long dry summer.

The other two plants of the community were suffering even more severely from lack of water. The leaves of the Mesembryanthemum were flaccid, those of *Frankenia pauciflora* were erect, parallel to the stems, and seemed dried up. The plant had a much more stunted habit than is usual. Its branches rose obliquely without the adventitious rooting observed when it grows in sandy soil.[12]

The consocies here described characterises most of the plain between the actual salt swamp and the higher-lying salt bush area. It is clearly halophytic, but is not permanent swamp; it is rather of the nature of an "alkali plain." Though the plants have a high salt toleration they are sharply defined from the actual swamp species, which replace them in local depressions.

Drainage channels.—Drainage channels, many of which are tidal at the lower portion of their course, and most of which would be flooded at ordinary spring tides, intersect the *Arthrocnemum halocnemoides* zone described above. They are conspicuous because they are colonized by *A. arbuscula,* which, owing to its taller growth and green colour, stands out distinctly above the lower red-brown of the *A. halocnemoides*. At the edge of some of the channels *A. leiostachyum* occurred.

The upper portion of the beds of the channels is bare, cracked mud. Water evidently remains for some time in local hollows, but these were all dry when examined. Large sheets of a felt-like material composed of *Cladophora* sp. were found in the hollows.

Banks of the drainage channels.—The banks of the drainage channels in the *A. halocnemoides* area are interesting because, in places, they tend to become raised above the general level of the rest of the plain. This is due to an accumulation of silt, *debris,* and shells that becomes banked up around the plants growing at the edges. Thus local "islands" occur fringing the channel. These small local patches of higher ground are usually only a few yards in length and not much more than a yard wide, but their edaphic conditions differ from the surrounding plain (see soil sample No. 6). The soil is less salt, drier, and has more organic matter in it. On such islands *A. paludosum* appears. The grey leaves of this plant are a striking contrast to the colour of the vegetation on either side. The occurrence of these outliers of the *Atriplex paludosum* consocies is a matter of some interest, for it indicates the importance of edaphic conditions in determining the distribution of the saltbush in the area (pl. xx., fig. 2).

Mixed shrub community on shell islands.—*Debris* deposited by flood tides accumulates not only besides the drainage channels but in various other places over the actual swamp area *(A. arbuscula* consocies). Shells of a cockle *(Chione* sp.) are most abundant, though a conical shell *(Bittium* sp.) is present in large numbers. Great quantities of the shells may accumulate against some large object and form mounds several feet high and many square yards in area. Several such islands were visited and will be briefly described.

The earliest stage seen was in the salt swamp area close behind the mangrove limit. There, a tree-trunk and other flotsam of the tide formed the basis of a mound composed chiefly of shells. This was colonized by *Nitraria Schoeberi,*

(12) Osborn, T. G. B., "Flora and Fauna of Nuyts Archipelago, No. 3. A Sketch of the Ecology of Franklin Islands," Proc. Roy. Soc. S. Austr., xlvi., p. 194, 1922.

a plant of remarkably varied habitat and possessing also a capacity for adventitious rooting.[18]

All the other islands seen represented older stages than that just described By successive deposition of more shells and *debris* the level of the islands had become raised well above the general level of the plain. The banks so formed were colonized by a mixed community of various shrubs, low trees, and annuals. The following is a composite list made from three such islands:—

Stipa teretifolia
Avena fatua
Bromus sp.
Dianella revoluta
Fusanus acuminatus
Exocarpus aphylla
Rhagodia baccifera
Atriplex paludosum
Threlkeldia diffusa
Tetragonia implexicoma
Mesembryanthemum aequilaterale
Silene gallica
Tillaea verticillaris
Acacia ligulata
Nitraria Schoeberi
Frankenia pauciflora
Alyxia buxifolia
Myoporum insulare
Olearia axillaris
Vittadinia australis
Senecio lautus

The soil analysis shows that the soil has a very low water retaining capacity; the soil was air dry when collected, with only 1·6 per cent. of moisture. That the soil is chiefly made up of shell grit is seen by the lime content of 90·7 per cent. Soluble salts in the soil were only 1·1 per cent., of which only 0·06 per cent. was sodium chloride.

Mosses were a prominent feature of the ground flora, and saxicolous lichens were present in quantity on the superficial layer of shell. The ecology of these islands and the relation of the florulas to that of the coastal dunes in the vicinity would be of interest, but it is not proposed to consider them further here. Attention may be drawn to the occurrence of *Atriplex paludosum* on the "islands," for they provide an obviously non-halophytic habitat.

Atriplex paludosum consocies.

A dwarf shrubland of *Atriplex paludosum* occupies the upper limits of the coastal plain. The grey colour of the dominant plant at once characterises the area, distinguishing it sharply from the *Arthrocnemum halocnemoides* shrubland on the seaward side. The ecotone line is sharp, a distance of three or four yards usually being sufficient to pass from the samphire community of the type described above to pure saltbush. The soil analyses of the transition region are given as No. 7 from *A. halocnemoides* zone and No. 8 near the junction, but definitely in the *A. paludosum* zone. The percentage of moisture in the soil as collected and of sodium chloride in No. 8 is only 50 per cent. of that found in No. 7. It will be seen, also, that the moisture content of the air dry soil indicates a lower water retaining capacity for the soil supporting the saltbush community. The *Atriplex paludosum* consocies is thus developed on a soil that is only moderately salt but with a low water retaining capacity; it is, in fact, a plant community developed on a xerophytic habitat rather than a halophytic one.

The following plants also occurred:—

Poa bulbosa
Thysanotus Patersonii
Atriplex semibaccatum
Bassia uniflora
B. biflora
Mesembryanthemum australe
Tillaea verticillaris
Frankenia pauciflora
Angianthus strictus

(18) Cannon, W. A., *loc. cit.*, p. 70.

Only three annuals are included in the list, but at the end of a long dry season most of the annual species would disappear. The dry climbing stems of *Thysanotus Patersonii*, which is a geophyte, were quite common amongst the stems of *A. paludosum*.

Drainage channels and hollows in the *A. paludosum* zone were colonized by *Arthrocnemum halocnemoides*, the lines of junction being very sharp (pl. xx., fig. 3).

Atriplex stipitatum community.

Remains of the indigenous flora are scarce behind the level coastal plain. Most of the inland area seen is entirely modified by farming, but near the head of the Gulf is an area of red sandy soil that has not been ploughed. This is colonized by a degenerate saltbush scrub, *Atriplex stipitatum* being the most abundant plant present. This species forms low rounded bushes about 50 cms. in diameter with an open spreading habit. Other plants present were:—

Lomandra effusa	*Enchylaena tomentosa*
Fusanus acuminatus	*Acacia* sp. (*Oswaldii ?*)

The list is certainly far from complete, but the combined effects of rabbits, heavy grazing, and the season of the year made it impossible to collect specimens suitable for identification. The interest in the area, however, lies in the development of the saltbush *A. stipitatum*.

The soil is of a very different type (sample No. 10). It is highly silicious, with only 9 per cent. of lime and 2 3 per cent. of organic matter. The soil was air dry when collected, and the moisture content of 2 5 per cent. indicates a very poor water retaining capacity. The most interesting difference, however, is that sodium chloride is present as a mere trace, 02 per cent.

DISCUSSION.

From the foregoing it is clear that the zonation noticed in the vegetation may be correlated with certain edaphic features of the environment. First, the range of water content of the different plant habitats may be expressed as follows:—

Arthrocnemum arbuscula	20-50 per cent.
A. halocnemoides	5-20 „ „
Atriplex paludosum	50-7 5 „ „
A. stipitatum	2 5 „ „

Further, if the salt content be considered, whether total salts or sodium chloride, a similar division of the soil analyses may be made:—

	Total Salts.	NaCl.
Arthrocnemum arbuscula ..	16 9-17 5 p.c.	15 70-16 71 p.c.
A. halocnemoides	2 9- 4 9 p.c.	2·30- 3 77 p.c.
Atriplex paludosum	1 6- 2 8 p.c.	0 78- 1 62 p.c.
A. stipitatum	0 3 p.c.	0 2 p.c.

From the above figures one can obtain a ratio expressing the proportion of salts to water in the soil at the time of our visit, *i.e.*, one can gain some idea of the density of the soil solution at that time of the year. This ratio is given below, taking total salts in the wet soil as unity, and giving the amount of water present in the soil as collected as a ratio of this figure. The results are as follows:—

Arthrocnemum arbuscula	1 : 3 8-4 0
A. halocnemoides	1 : 4 3
Atriplex paludosum	1 : 3 0-3 3
A. stipitatum	1 : 8 3

It follows that *A. paludosum* has in contact with its roots a solution that is actually denser than that in which the salt marsh plants are growing. But this solution was not being absorbed by the roots in March, for, as noted above,

A. paludosum was in a wilting condition. In the *Arthrocnemum halocnemoides* zone the proportion of salts to water is slightly less than in the case of *A. arbuscula.* But, whereas, the latter plants were growing thriftily, the former were markedly collapsing, the cortex of the plants as collected being shrunken and wrinkled.

If, however, we take the proportion of salts to water in the saturated soil, using the percentages given on page 249 a different result is obtained. The ratio of salt to water becomes:—

Arthrocnemum halocnemoides	1: 12
Atriplex paludosum	1: 29
A. stipitatum	1:120

This, we believe, expresses more accurately the degree of salinity of the soil solution in the respective zones during the wet season. They confirm our conclusions that the zonation of the vegetation observed is correlated with a decrease in the salinity of the soil, and that this is accompanied by an increasing aridity of the environment.

The figures given by us for the total salinity of the different zones, high though they are, are actually less than the percentage of total salts in the soils of "alkali lands" of the United States of America. Hilgard[14] gives his figures as pounds per acre feet. We have taken the results as given by him and converted them to percentages of "wet" soil by taking 3,750,000 lbs. as the weight per acre foot of soil (*vide* Hilgard, p. 444). The results for certain of the character plants of the alkali lands are:—

Allenrolfia occidentalis	13 2 per cent. total salts
Salicornia subterminalis	11 8 „ „ „
Frankenia grandiflora	7 5 „ „ „
Suaeda Torreyana	3 5 „ „ „
Sarcobatus vermiculatus	1 5 „ „ „

It is for comparison with these figures that we have given the percentage of salts to wet soil in our table on page 248.

The zonation of the vegetation around a salt lake in an arid region has been studied in some detail by Kearney and his co-workers[15] in Tooele Valley, Utah. The observations made by us are in general agreement so far as the zoning of comparable plants is concerned. It is interesting to notice that at Tooele the salt swamp plant is *Allenrolfia,* and that *Atriplex confertifolia* grows on the less salt portions. This plant, from its general relations, appears to correspond to our *A. paludosum. Atriplex stipitatum,* the chief constituent of the saltbush area (using the term in its generally accepted Australian sense) corresponds rather to the North American sage brush, *Artemesia tridentata;* that is, to a plant of arid regions with only a low salt concentration in the soil.

EXPLANATION OF PLATE XX.

Fig. 1. General view in *Arthrocnemum arbuscula* zone, showing a bare creek to right. The mounds and bushes in the middle distance are "shell islands." On the horizon are the hills of Yorke Peninsula across Gulf St. Vincent.

Fig. 2. Creek in the *Arthrocnemum halocnemoides* zone. The figure to the left stands on a raised bank, on which are bushes of *Atriplex paludosum.* The figure to the right is in the creek bed; in this grow bushes of *Arthrocnemum arbuscula.*

Fig. 3. Junction of the *Atriplex paludosum* zone and the *Arthrocnemum halocnemoides* zone, seen in the lower land to the right.

(14) Hilgard, E. W., *loc. cit.*, p. 549.

(15) Kearney, T. H., L. J. Briggs, H. L. Shantz, J. W. McLane, and R. L. Piemeisel, "Indicator Significance of Vegetation in Tooele Valley, Utah," Journ. Agr. Research, i., pp. 365-417, 1914.

THE GEM SANDS OF ENCOUNTER BAY.

By R. Grenfell Thomas.

[Read September 13, 1923.]

The beach sand at several points in the vicinity of Encounter Bay has long been known to yield a so-called "gem sand" where concentrated by wave action.

The underlying rock formations comprise intrusive granite and a series of thermally metamorphosed sedimentary rocks, which are taken to be of Pre-Cambrian age. These older rocks are overlain at intervals by irregular and discontinuous patches of glacial drift of Permo-Carboniferous age.

As this sand is representative of the heavy mineral content of the area, its composition may be expected to furnish interesting evidence of the alterations occasioned by thermal contact metamorphism in this region. It was primarily with a view to ascertaining the mineral composition of the sand that the following investigation was undertaken.

Mode of Occurrence.

The gem sand, which is conspicuous by its red colour, occurs as irregular thin-bedded sheets on the beaches in question near high-water mark. The presence of concentrated deposits of the sand in any one area is not necessarily dependent on the immediate proximity of rocks in which the constituent minerals occur *in situ,* but is largely influenced by prevailing currents, slope of beach, and general coastal configuration. Although concentration by wave action is the chief factor influencing the deposition of the sand, the effect is often amplified by the selective action of winds on the sand dunes, whereby the lighter grains are carried away, leaving a residue of higher specific gravity.

Localities.

The chief areas of deposition in Encounter Bay can be grouped under two headings: (1) At Rosetta Head; (2) at Middleton Beach. For purposes of comparison it is convenient to divide the Rosetta Head deposits into two classes: —*(a)* Those on the west side of Rosetta Head, or the "Petrel Cove" type; *(b)* those on the east side of Rosetta Head, or the "Bluff Bay" type. At these localities the gem sand is present in greater or less quantity throughout the year, although the concentrated deposits are often temporarily disseminated by heavy seas.

Collection of Samples.

Representative samples of sand from the localities mentioned were collected and were each concentrated in the field, by "panning," to a well-defined stage immediately preceding a loss of the heavier constituents. The material thus eliminated was found to consist of quartz and shell fragments, and contained none of the heavier minerals which it was desired to examine. In this way samples, weighing about 10 lbs., after concentration, were obtained from each locality. These samples may be regarded as thoroughly representative of the several deposits, and thus afforded standards for comparison of the different types.

Mechanical Analysis.

An approximate determination of the average size of the grains in each sample of sand was made by using a micrometer eyepiece fitted to the microscope. This method gave the following results:—

	Diameter in millimetres.		
	Petrel Cove.	Bluff Bay.	Middleton.
Average diameter of largest grains ..	1 mm.	·5 mm.	·5 mm.
The majority of the grains range from ..	·5-·3 mm.	·3-·2 mm.	·2-·1 mm.

Quantitative Separation into Magnetic Groups.

The method of examination followed was essentially that recommended by T. Crook.[1] This comprised a preliminary separation of the constituents into groups of varying magnetic permeability by means of an electro-magnet fitted with adjustable pole pieces for altering the intensity of the magnetic field.

It was found that the component minerals of the sand could by this means be separated into five well-defined groups, and since in each case a weight of 20 grams of sand was used, the relative weights of each group afforded a means of comparing the three types of sand. The following groups were thus recognized:—

(1) Highly magnetic, represented by ..	Magnetite
(2) Moderately magnetic, represented by ..	Ilmenite
(3) Appreciably magnetic, represented by ..	Garnet
(4) Weakly magnetic, represented by ..	Staurolite
(5) Non-magnetic, represented by	Zircon

The relative proportions of the various groups in the three types of sand were found to be as follows:—

Percentage Weights.

	Petrel Cove.	Bluff Bay.	Middleton
Magnetite Group	1	5	1 0
Ilmenite Group	1 8	3 3	8 0
Garnet Group	54 8	57 3	75 0
Staurolite Group	1 4	1 0	5 5
Zircon Group	41 9	37 9	10 5

Component Minerals of the various Magnetic Groups.

The separation and identification of the component minerals was effected by a series of heavy liquid flotations and electrostatic separations, coupled with microscopical examination.

Owing to the relatively high specific gravity of most of the minerals the use of heavy liquids for separation was necessarily somewhat restricted, but Methylene Iodide (S.G. 3 3) and fused Mercurous Nitrate (S.G. 4 3) were found very useful in certain cases.

In some instances it was found that certain of the minerals showed varying magnetic permeability, probably owing to inclusions of foreign material; this caused them to appear in two or more of the magnetic groups. Separation in these instances was effected by electrostatic methods, a process well adapted for the separation of Ilmenite from the Garnet or Staurolite Groups.[2] The following minerals were identified:—

From Magnetite Group ..	Magnetite
Ilmenite Group ..	Ilmenite
Garnet Group	Almandine
Staurolite Group ..	Staurolite, Green Spinel, Tourmaline
Zircon Group	Zircon, Kyanite, and Rutile

Each of the three types of sand was found to contain the same set of minerals, and as the properties of any one mineral were, in general, common to that type at each locality, it is convenient to group the petrological features collectively.

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(1) *Vide* Text-book of Petrology, "The Sedimentary Rocks," by Hatch and Rastall. Appendix by T. Crook. Page 339, *et seq.* London, 1913.

(2) *Vide* Mineralogical Magazine, vol. 15, p. 260.

The refractive indices were obtained by the Shroeder van der Kolk method of oil immersion, while the specific gravities were determined with a Pycnometer.

Petrological Features of the Minerals.

MAGNETITE.—The grains are rather variable in appearance, some being lustrous black, others dull and rusty. They are always opaque and generally well rounded, but occasionally abraded octahedrons are present. The specific gravity varies considerably in different samples owing to partial hydration, etc., but ranges between 4·1 and 5·1.

ILMENITE.—Opaque grains, black and lustrous, chiefly well rounded, but sometimes platy or showing abraded crystal forms. Many of the grains show patches of yellowish-white leucoxene. The magnetic permeability varies considerably in different grains, probably in accord with a fluctuation in the titanium content. Specific gravity is 5·02, a value corresponding to titaniferous magnetite rather than ilmenite proper.

ALMANDINE GARNET.—Occurs essentially as irregular grains with rounded outlines, though well-formed crystals are occasionally to be seen, especially in the Petrel Cove sand. The colour varies from light pink to deep red. The grains are perfectly isotropic and show no sign of cleavage. The refractive index is high and greater than that of methylene iodine. Some of the grains show an abundance of solid black inclusions. The specific gravity is 4·16.

TOURMALINE.—Rather common, as well-rounded grains, in the Middleton sand, rarer in Rosetta Head deposits, but more frequently euhedral. Colour very variable, from light smoky-grey through brown to bluish-black or opaque. Pleochroism very strong, light-coloured varieties giving complete absorption of the ordinary ray. No cleavage shown, prismatic forms give straight extinction. Refractive index high, about 1·63. Some grains show acicular inclusions. The specific gravity varies from 3·1 to 3·3.

GREEN SPINEL.—Typically as rounded grains of olive-green to light-green colour. Occasionally an abraded octahedral form occurs. No cleavage observable. With crossed nicols the grains are quite isotropic. Inclusions are rare though acicular rods sometimes occur. Refractive index high and near to that of methylene iodide, about 1·72. Specific gravity, 4·0.

STAUROLITE.—This mineral is the chief component of the weakly magnetic group. Although very variable in appearance most of the grains are anhedral with a pronounced rough surface, due to an abundance of solid inclusions. Well-formed crystals are occasionally present in the Petrel Cove sand. The colour varies from brown to yellow in the opaque grains, and in the rarer transparent varieties it is a deep reddish-brown. The clear grains show strong pleochroism in yellow and brown, and also give straight extinction. The refractive index is high and very near to methylene iodide; the birefringence is moderately low.

An interrupted cleavage, parallel to (010), is occasionally shown; twinning not observed.

The nature of the inclusions varies considerably; in some instances they are gaseous, but more commonly appear to consist of quartz; occasionally they are carbonaceous, but in no instance is there a symmetrical distribution of the included material.

The specific gravity varies considerably; in the purer varieties it is generally 3·57, but often falls as low as 3·45, when inclusions are abundant.

KYANITE.—Rather common in the non-magnetic group. Almost invariably as flat grains and lath-shaped forms. Colour generally bluish-green but often colourless or altering to brown among the cleavage cracks. Many grains show colourless borders and blue centres. Cleavage cracks, parallel to (001), are generally shown across the laths.

Pleochroism often rather weak, in coloured grains only. Refractive index high, a little less than that of methylene iodide, about 1·71.

Solid inclusions often plentiful and occasionally take the form of acicular rods arranged either in "sagenite fashion" or in a confused felt-like swarm, the habit and optical properties corresponding to sillimanite.

Owing to the perfect (100) cleavage the plates are usually lying on this face, and hence show the almost normal emergence of the acute bisectrix, thus giving good biaxial figures when examined in convergent light. The optic axial angle is large and the optic sign negative. The specific gravity is 3 62.

RUTILE.—Common in the non-magnetic portion of the sand as abraded rods and round grains. The Petrel Cove sand often shows good euhedral forms with striated prism faces; geniculate twins also occur. The colour is generally very dark but varies considerably; the Middleton sand shows the lightest reds. By reflected light the grains show the typical semi-metallic lustre. The pleochroism, when observable, is slight. Refractive index extremely high, birefringence also very high, extinction straight.

A weak cleavage (110) is sometimes noticeable. Inclusions rare. The specific gravity is 4 35.

ZIRCON.—Abundant in the non-magnetic group. Almost invariably in abraded anhedral grains, traces of crystal form being very rare. The grains are always perfectly colourless. Refractive index very high, birefringence also very high Straight extinction shown. Inclusions very rare. The specific gravity is 4 71.

The Origin of the Component Minerals.

As regards the origin of the various minerals occurring in the sand, it appears most probable that the majority of the constituents are derived from the regions of contact thermal metamorphism produced by granitic intrusions of the Pre-Cambrian sedimentary series which occurs in this area.

Some of the constituents, such as staurolite and kyanite, are certainly not derived from the igneous rocks, and although several of the other minerals such as rutile, zircon, and garnet are often of magmatic habit, they have not been observed to be common constituents of the igneous rocks of this region, which have been petrologically examined by W. R. Browne[8] and others. There can, however, be little doubt that, in some instances, the mineralizing influence of the intrusive granite has played an important part in their formation.

That the constituents of the sand are genetically connected with the metamorphic aureoles is further supported by the fact that those sands occurring furthest away from the contact zones invariably show the greatest abrasion and rounding of the grains, while those adjacent to the contact zones generally contain larger and more angular grains which are often euhedral. Thus the Petrel Cove deposits, occurring in the midst of a strongly metamorphosed region, show considerably larger and less abraded grains than the Middleton sand, which appears to travel along the coast from the contact zones at Port Elliot, a distance of about two miles.

Summary.

The gem sand of Encounter Bay contains the following minerals:—Magnetite, ilmenite, almandine garnet, staurolite, green spinel, tourmaline, kyanite, rutile, and zircon. The minerals being of relatively high specific gravity are concentrated on the sea beach by wave action. The component minerals appear to be chiefly derived from the metamorphic aureoles resulting from the intrusion of an acid magma into a Pre-Cambrian sedimentary series. The sands from various localities in Encounter Bay contain the same set of minerals but the relative proportions of the minerals are not constant throughout the area.

Geological Laboratory, Adelaide University,
August 9, 1923.

[8] *Vide* "The Igneous Rocks of Encounter Bay," by W. R. Browne, Trans. Roy. Soc. S. Austr., xliv., p. 1.

ON TRANSPIRATION IN THE FIELD OF SOME PLANTS FROM THE ARID PORTIONS OF SOUTH AUSTRALIA, WITH NOTES ON THEIR PHYSIOLOGICAL ANATOMY.

By J. G. Wood, B.Sc., Demonstrator in Botany, University of Adelaide.

[Read September 13, 1923.]

Plate XXI.

The Australian flora presents a great range of variation in form and some remarkable structural features arising from the arid conditions. There has been a surprising neglect of quantitative experimental work attempting to correlate these modifications with the physiological processes of the plants. Ewart (1910) determined the transpiration rates of three species of *Eucalyptus (E. viminalis, E. corynocalyx, and E. maculata)*, but the work was mainly concerned with the problem of the ascent of the sap. More recently Cannon (1921) has described the anatomy of several species of plants from the arid portions of South Australia in relation to various ecological factors, chiefly the problem of the water supply.

The following paper first describes the transpiration rates of six species of plants in relation to various external factors, and, secondly, attempts to correlate the transpiration rates with the histological modifications which are developed in the transpiring organs.

I. TRANSPIRATION.

Physical Environment.—The experiments were carried out in the field at Dilkera, a sheep station about 10 miles north of Mount Mary, a small township on the Morgan railway line, and 90 miles north-east of Adelaide. Dilkera is in the Murray basin, and has an average annual rainfall of 9·28 inches (Morgan). A visit was made during the third week of May of this year; this was towards the end of a period of about five months' drought, and the weather was typical of autumn conditions in this region. At this period of the year the country is subject to strong westerly and south-westerly winds, which sweep over the plains from the Mount Lofty Ranges. These winds are dry and often travel at a high velocity. As will be shown below, they are an important factor in determining the rate of transpiration.

As regards vegetation, the chief communities are an open woodland of *Casuarina lepidophloia* or various mallees *(Eucalyptus* spp.), in conjunction with undershrubs, the chief being *Atriplex vesicarium* and *Kochia sedifolia*. The transpiration experiments were carried out under as natural conditions as possible. The situation is shown in pl. xxi., fig 2. The chief shrub is the "bluebush," *Kochia sedifolia*, with remains of bushes of *Atriplex vesicarium*, though most of the latter have been eaten out by grazing animals. The trees are *Casuarina lepidophloia* and *Myoporum platycarpum*. The apparatus was fully exposed to all climatic factors and only protected from grazing animals by a single barbed-wire enclosure.

The plants selected for experimentation were *Casuarina lepidophloia* (F. v. M.), *Geijera parviflora* (Lind.), *Pholidia scoparia* (R. Br.), *Atriplex vesicarium* (Hew.), *Kochia sedifolia* (F. v. M.), and *Rhagodia Gaudichaudiana* (Moq.).

Methods.

1. *Measurement of Transpiration.*

It was impossible to measure the loss of water by transpiration by weighing owing, first, to the difficulty of access to Dilkera with the necessary instruments of precision, and secondly, to the size of some of the plants and the great length of time which must elapse before potted plants are ready for experimentation. The means adopted, therefore, was that of measuring the loss of water from cut shoots in a potometer. The burette form of potometer described by Lloyd (1908) was adopted. This instrument is capable of measuring the loss of water to within 05 c.c., an accuracy which is not attainable with most forms of potometer balance. Further, the burette type has been used by students in the University under the writer's supervision, and has been found to give very uniform results with the one species of plant. This form of potometer has also the advantage of rapid and accurate reading, and it is believed that the results would differ very little from those obtained by other methods provided that the precautions mentioned below be observed.

The shoots were cut under water early in the morning, carefully trimmed with a sharp knife, and the green cortex stripped away to prevent clogging of the vessels by bacterial decomposition. The wood was inserted into rubber tubing of 5 mm. diameter previously filled with water and attached to the burette. By means of the rubber tubing a good water-tight joint is obtained. The shoots were supported vertically.

No readings were taken for the first hour and a half in order that the shoots might become turgid. In any case, Lloyd (1908), using American desert plants, has found that the difference between the amount of water transpired and the amount absorbed is practically negligible. Thus the loss from the burette measures directly the amount of water transpired by the shoots. Although it is not claimed that the burette potometer gives absolute readings for the transpiration rates, it does give relative readings, so that the rates are strictly comparable, which is the main requirement for the present considerations.

The tops of the burettes were covered with small specimen tubes to prevent evaporation from the meniscus. The battery of potometers was erected on a stand improvised on the spot, and is shown in pl. xxi., fig. 1.

2. *Measurement of the Climatic Factors.*

(a) Temperature.—The temperature was measured in degrees Fahrenheit by means of a thermometer attached to the potometer stand.

(b) Light Intensity.—The measurement of light intensity has been neglected by many workers on transpiration and photosynthesis, such terms as "dull," "bright," etc., having little value. Inasmuch as it is a factor in stomatic control it cannot be neglected. The intensity of illumination was measured by a simple type of actinometer, namely, by noting the time taken for a strip of sensitive paper to become the same shade as a standard fixed disc. The relative intensities are plotted on the curves in seconds. Readings were taken every half-hour, as shown on the curves; only the hourly readings appear in the table, fig. 2.

(c) Relative Humidity.—This was determined by means of wet and dry bulb thermometers which were protected from the wind. The wet and dry bulb readings were reduced to "relative humidity" by means of Glaisher's formula.

(d) Evaporating Power of the Air.—A method sensitive to slight variations in evaporating power from hour to hour was necessary, and the type of atmometer used by Livingston (1906) was employed. The apparatus consisted of a

Chamberland-Pasteur filter candle, Type B, of unglazed porcelain, attached by rubber tubing to a burette, the whole being completely filled with water. This atmometer was also attached to the potometer stand. For absolute measurements it must be calibrated in terms of the loss from a free water service. This was done on return to Adelaide by exposing in the same place the atmometer and a Petri dish filled with water. The latter vessel was weighed each time a reading was taken on the atmometer. From these data it was found that the çandle surface was equivalent to 100 sq. cms. of free water surface. The evaporating power is measured by the loss of water per sq. cm. of free water surface.

Fig. 1 gives the curves for the various climatic factors. The quantities of the latter are plotted as ordinates and time in hours along the abscissa. As regards temperature, it will be seen that this did not vary greatly throughout the time of experimentation, but fell gradually from 2 p.m. The evaporating power was fairly high throughout the day, but fell rapidly at night. The evaporating power is the product of several factors—relative humidity, wind, sunlight, and temperature. It will be seen that the evaporation curve does not coincide exactly with the curve for the relative humidity during the day period, though the coincidence is exact during the night. This is due to the high wind which commenced at 9 a.m. and did not fall until 5 p.m. The wind, as before mentioned, has a high velocity, and appears to be the dominant external factor in transpiration. At 3 p.m. it was blowing with very strong gusts, and the curve maximum shows its effects on evaporation. The relative humidity calls for little comment. The high value during the night common in this region should be noted. It is due to the low temperatures prevailing. The minimum night temperature recorded was 38° F.

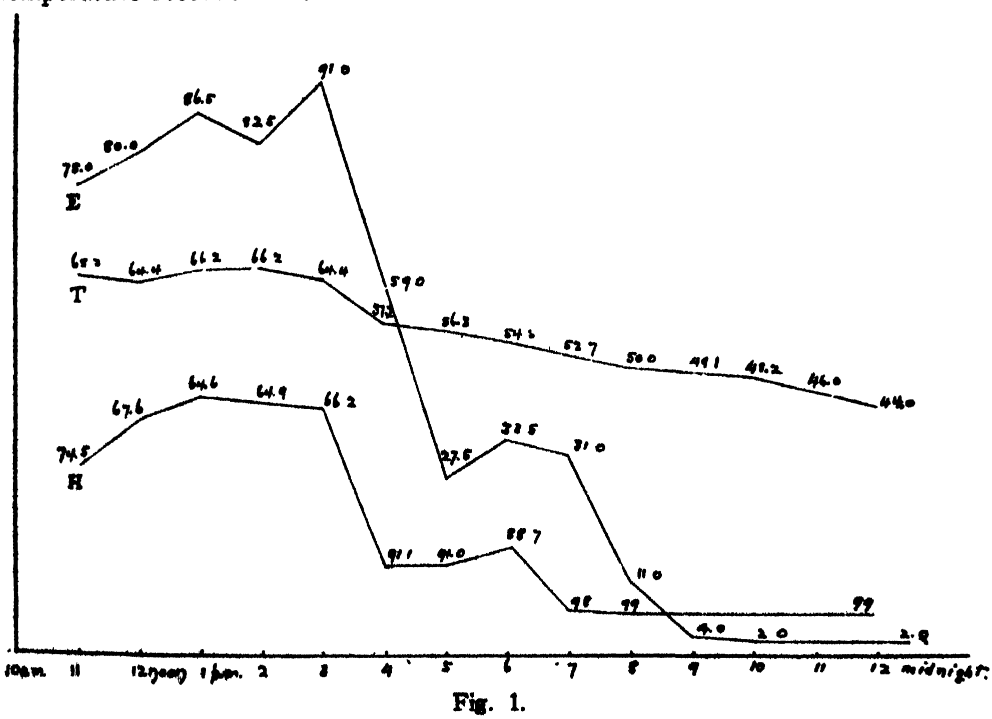


Fig. 1.

Curves of external factors influencing transpiration. E, Evaporating Power; T, Temperature; H, Relative Humidity.

3. *Calculation of Leaf Areas.*

To express the transpiration rate in terms of the weight of water transpired per sq. cm. per hour it is necessary to determine the total transpiring area. This was a tedious matter, as it necessitated the computing of several hundreds of leaves. In the case of *Atriplex* and *Rhagodia* the leaf outlines were traced on paper, cut out, weighed, and compared with the weight of a known area of the paper, and from this the area was calculated. *Casuarina, Pholidia,* and *Kochia* were treated as cylinders, the total length being measured, and also the diameter, the latter by means of an objective micrometer. In the case of *Pholidia,* the areas of leaves of stem were calculated separately. The leaves of *Geijera* were treated as rectangles. All the flat leaves had stomates on both sides; the areas obtained by the above methods were therefore doubled in these cases.

The number of leaves and the total transpiring areas of the shoots were as follows:—

Plant.	Number of Leaves.	Total Transpiring Area (sq. cms.).
Casuarina lepidophloia	71	392 4
Geijera parviflora	154	459 1
Pholidia scoparia	155	198 1
Atriplex vesicarium	258	446 1
Rhagodia Gaudichaudiana	330	690 6
Kochia sedifolia	2,800	714 7

RESULTS.

Fig. 2 is a table embodying the results obtained. Transpiration is given by the figure opposite each species of plant and represents the loss of water in milligrams per sq. cm. The atmometer readings are reduced also to the loss in milligrams per sq. cm. The light intensity is given in seconds, the relative humidity in percentages, and the temperature in degrees F.

No readings were taken between 11 p.m. and 7 a.m. next morning. The small amount of water transpired during this period is shown below. Assuming that the transpiration rates were constant during this period the hourly losses were:—

Atriplex vesicarium	09 mg.
Rhagodia Gaudichaudiana	·07 mg.
Kochia sedifolia	07 mg.
Geijera parviflora	08 mg.
Pholidia scoparia	·10 mg.
Casuarina stricta	·10 mg.
Atmometer	·70 mg.

Time.	11 a.m.	12 noon	1 p.m.	2	3	4	5	6	7	8	9	10	11
Casuarina lepidophloia	·50	1·53	1·65	2·29	2·67	1·14	·76	·25	25	·25	·13	·18	·13
Geijera parviflora	·20	·22	·22	·22	·33	22	·22	·11	·11	·22	·11	·07	·07
Pholidia scoparia	·75	·75	·75	1·00	1·00	·50	50	·35	·25	·5	5	·25	·25
Atriplex vesicarium	·34	·34	·34	·34	34	·34	·22	·22	·11	·22	·10	·10	·10
Rhagodia Gaudichaudiana ..	·21	21	·21	·21	·21	·14	14	·07	·07	·07	·14	·07	07
Kochia sedifolia	·14	·14	·14	·14	·14	·14	·14	14	·14	·14	·07	·07	·07
Atmometer	74·0	80 0	86·5	82 5	91·0	59·0	27 5	83 5	31·0	11·0	4·0	2·0	—
Relative Humidity	74·5	67·6	64 ·6	64·9	66·2	91·1	91 0	88 7	·98	99	·99	·99	·99
Temperature	65 2	64·4	66·2	66·2	64 4	57 2	56 3	54·5	52·7	50·0	49·1	48·2	46·0
Light Intensity	11·0	8·5	8·0	9·0	7·0	17 0	—		—	—	—	—	—

Fig. 2.

The curves plotted from these data are shown in figs. 3-8. Along with the transpiration curve are given those of the various climatic factors. Various scales were employed in order that the curves all might be brought within the same figure. The absolute values are given for each point.

From an examination of these curves it becomes evident that one can place the plants, according to the results obtained, under three separate groups.

The first group contains only *Casuarina lepidophloia,* which is distinguished from the other plants by its relatively high transpiration rate and also by its very close approximation during the day to the curve for evaporating power.

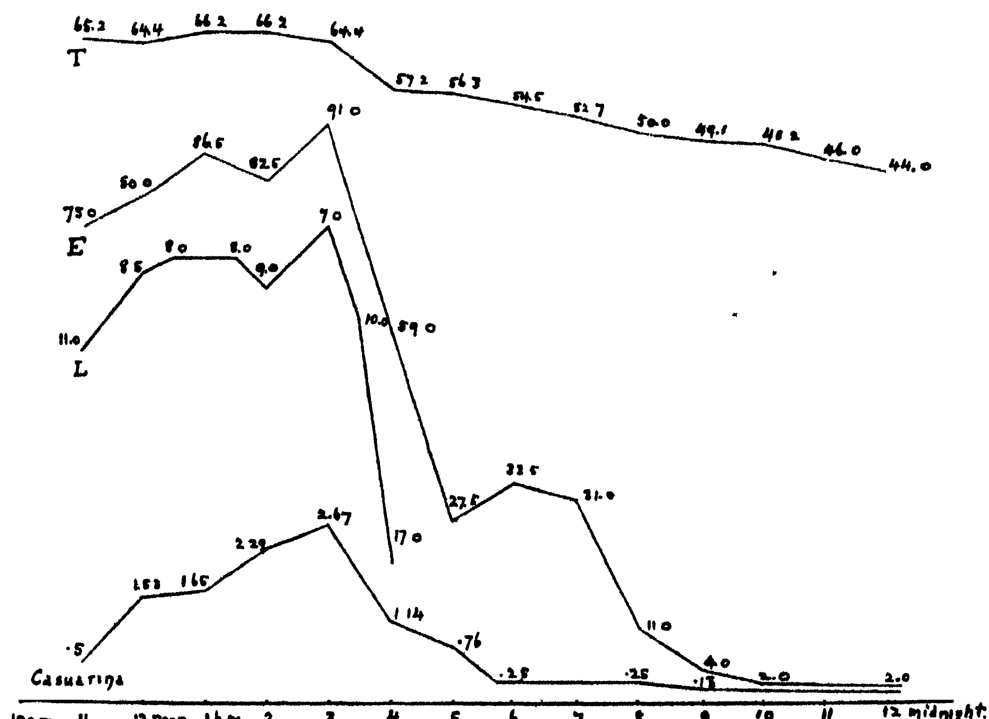


Fig. 3.

Curve for rate of transpiration of *Casuarina lepidophloia.*
T, Temperature; E, Evaporating Power; L, Light Intensity.

In the second group are *Geijera parviflora* and *Pholidia scoparia.* The transpiration rate of both these plants is low, and although they attain their transpiration maxima coincidently with the maximum value for the evaporating power, it is evident from their lack of agreement with the latter curve that they do not respond so readily to slight variations in the evaporating power of the air. Both plants also exhibited a second maximum at 8-9 o'clock in the night.

The third group contains *Atriplex vesicarium, Rhagodia Gaudichaudiana,* and *Kochia sedifolia,* and these I have further subdivided into *(a) Atriplex* and *Rhagodia, (b) Kochia.* All the species in this group are characterised by their transpiration curves running parallel to the time axis for a considerable period during the day; that is, their transpiration rates appear to be independent of the physical conditions. In the case of *Atriplex* and *Rhagodia* the transpiration rate began to fall about 4 o'clock, whilst in *Kochia* the constant loss rate continued until 8 o'clock.

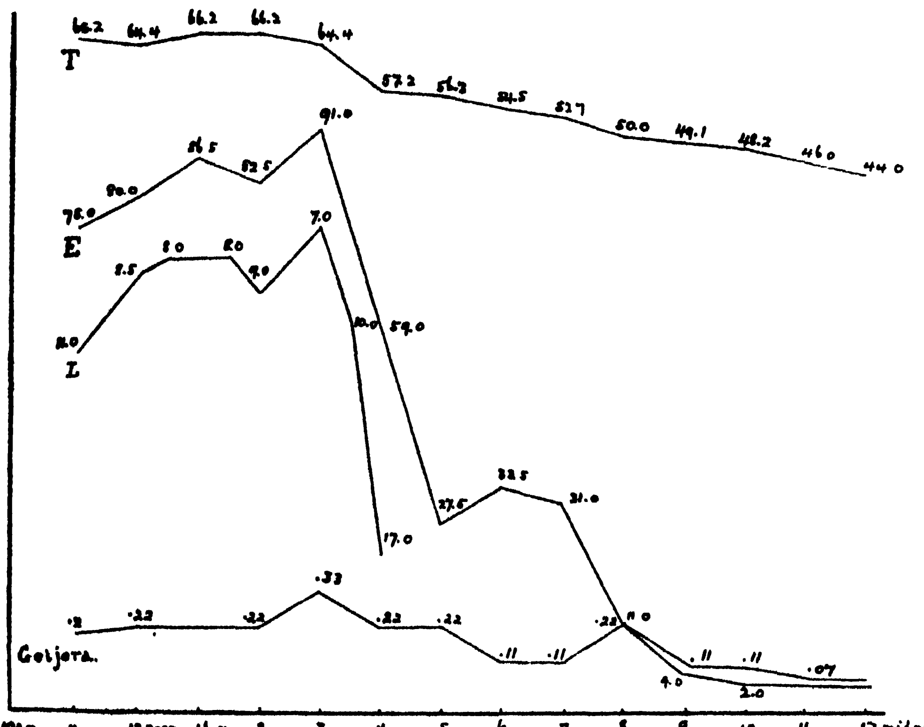


Fig. 4.

Curve for rate of transpiration of *Geijera parviflora.*
T, Temperature; E, Evaporating Power; L, Light Intensity.

It is evident that these curves cannot be interpreted on the basis of the external physical factors alone, and therefore a study was made of the anatomy of the plants from a physiological point of view. On so doing it was found that the transpiration loss could be correlated with the structure of the transpiring shoot, and that the plants could be divided into three classes according to their histological modifications, and, further, that these three classes coincided exactly with those groups which were created from a physical analysis of the curves. Before discussing the transpiration of the shoots in the light of their physiological anatomy a brief description will be given of their structure.

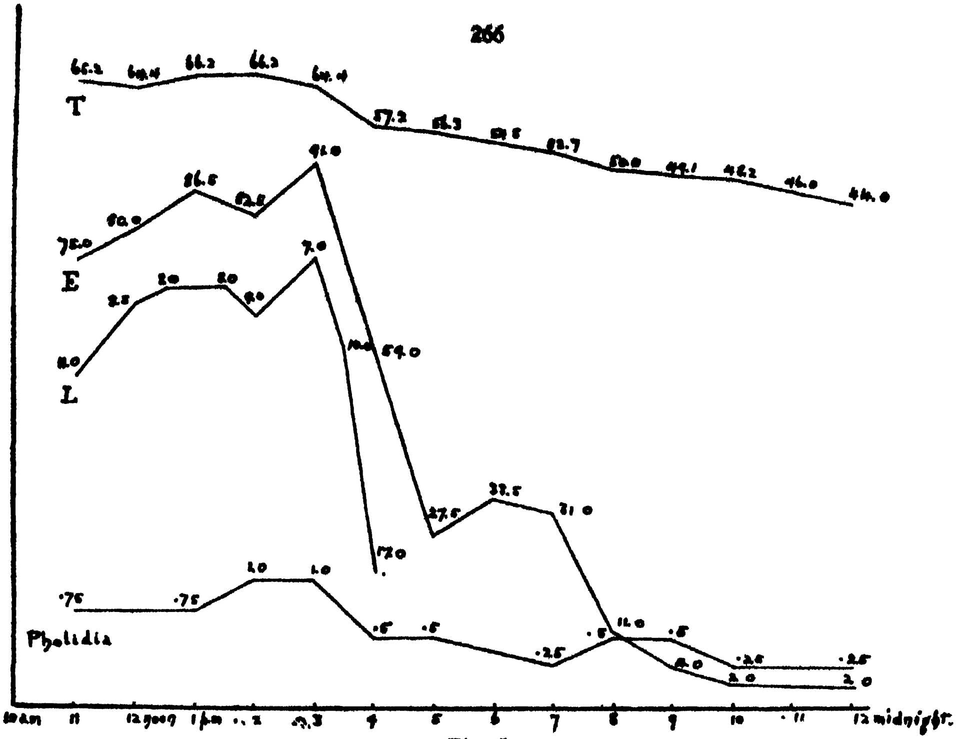


Fig. 5.
Curve for rate of transpiration of *Pholidia scoparia.*
T, Temperature; E, Evaporating Power; L, Light Intensity.

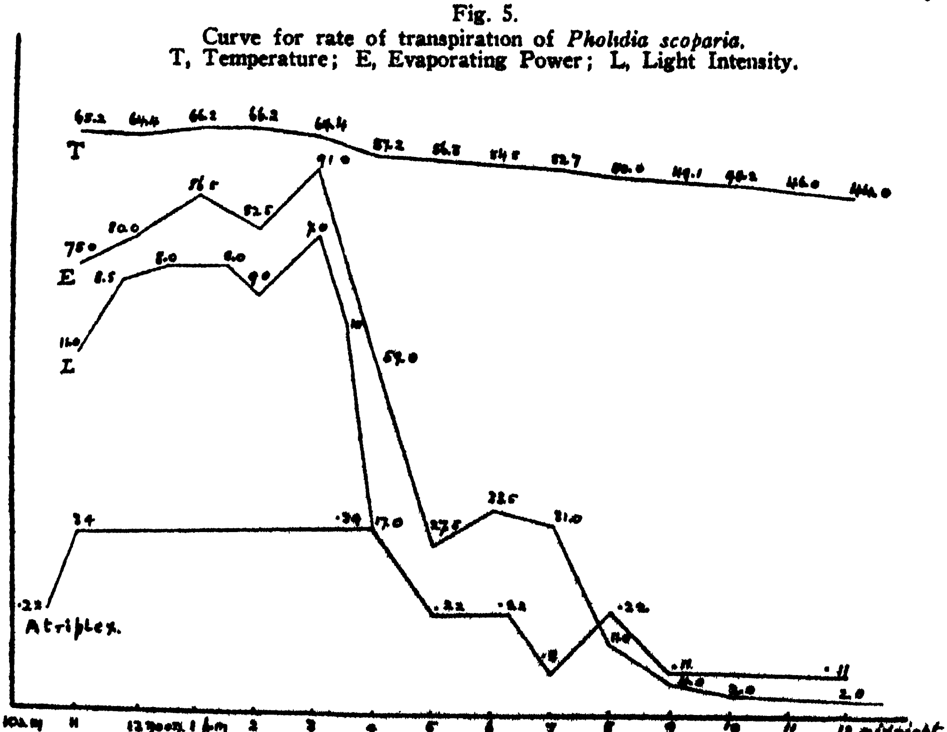


Fig. 6.
Curve for rate of transpiration of *Atriplex vesicarium.*
T, Temperature; E, Evaporating Power; L, Light Intensity.

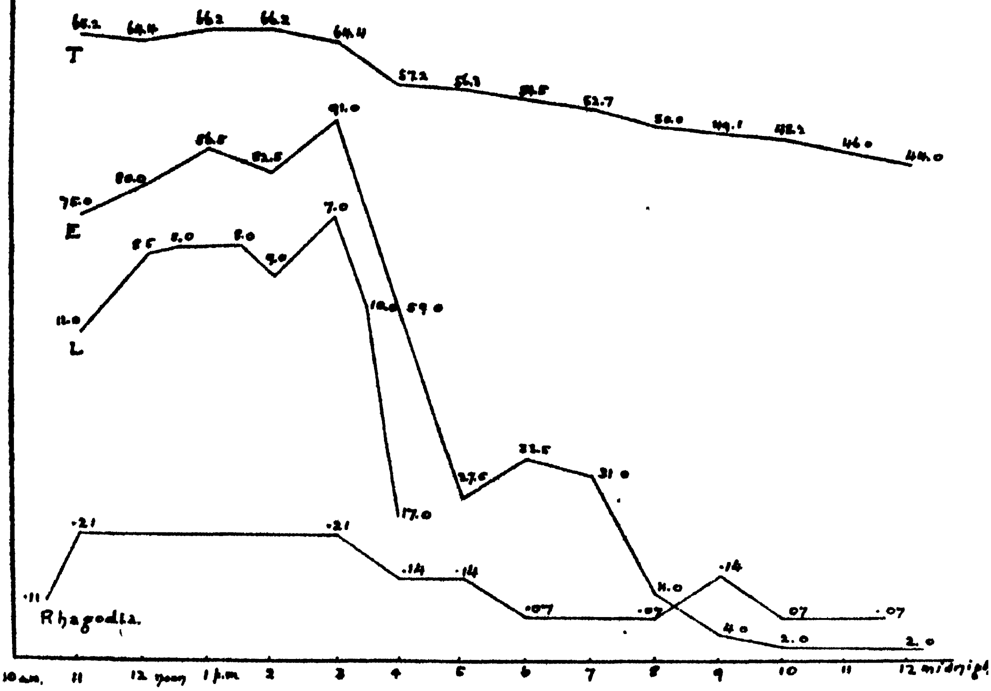
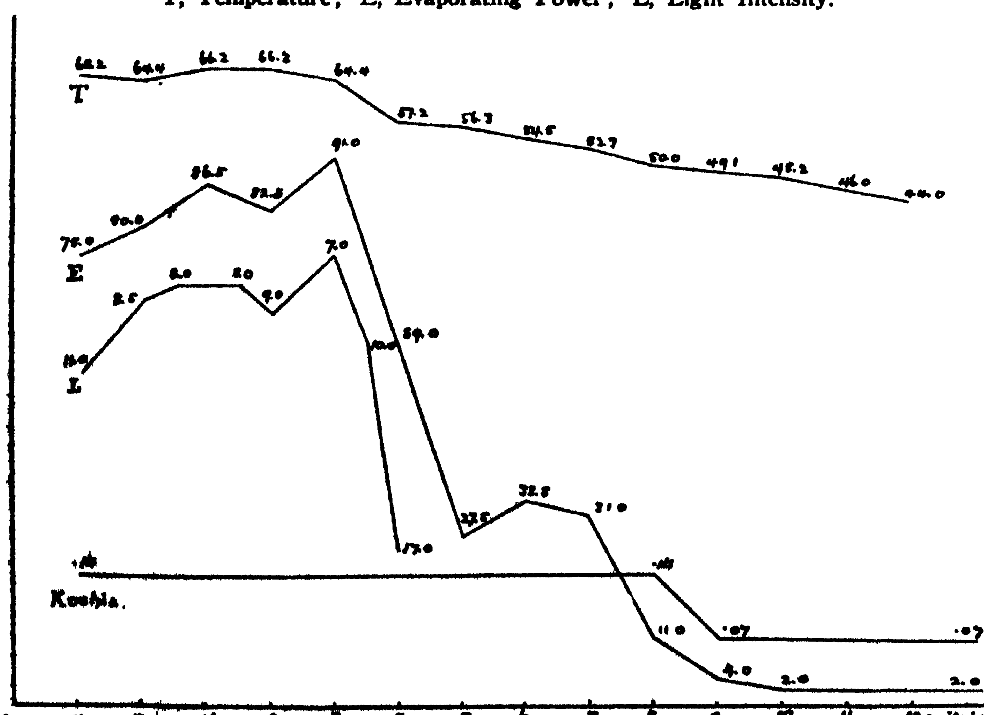


Fig. 7.
Curve for rate of transpiration of *Rhagodia Gaudichaudiana*.
T, Temperature; E, Evaporating Power; L, Light Intensity.



Curve for rate of transpiration of *Kochia sedifolia*.
Temperature; E, Evaporating Power; L, Light Intensity.

II. NOTES ON THE PHYSIOLOGICAL ANATOMY OF THE SHOOTS.

As far as I have been able to find, no description of the anatomy of the six plants used in these experiments has been published with the exception of *Atriplex vesicarium*. The observations have been confined chiefly to the tissues concerned in the water relations of the plants, and in most figures no attempt has been made to fill in histological details. All the figures are drawn from camera lucida outlines.

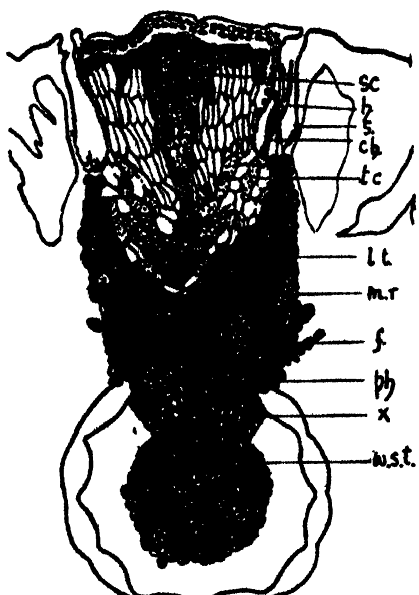


Fig. 9.
Transverse section of the assimilating shoot of *Casuarina lepidophloia*. *s.c.*, Sclerenchyma; *h*, Branched hair; *s.*, Stomate; *ch.*, Chlorenchyma; *t.c.*, Transfusion cells; *l.t.*, Leaf-trace bundle; *m.r.*, Medullary rays; *f.*, Phloem fibres; *p.h.*, Phloem; *x.*, Xylem; *w.s.t.*, Water-storage tissue. ×66.

Casuarina lepidophloia. (Fig. 9.)

This tree is very common around Dilkera and frequently attains a height of 30-40 feet. Attention was confined to the anatomy of the green assimilatory shoots. These stand erect and are usually from 6 to 12 inches in length with twelve ribs, the grooves running the whole length of the shoot. The anatomy of the Casuarineae as an Order has been surveyed by Morini (1894), and to this account *C. lepidophloia* conforms generally. It shows, however, xerophytic features to a remarkable degree. This is noticeable particularly in the extreme "woodiness" of the shoot. For the sake of comparison the tissue outlines of *C. distyla* (a species occurring in the Mount Lofty Ranges, Kangaroo Island, and other places with a rainfall of 25-30 inches), and *C. stricta* (which has a wider distribution) are appended (figs. 10 and 11). It will be seen that there is a progressive development of lignified tissues in passing from the relatively mesophytic *C. distyla* through the intermediate *C. stricta* to the xerophytic *C. lepidophloia.*

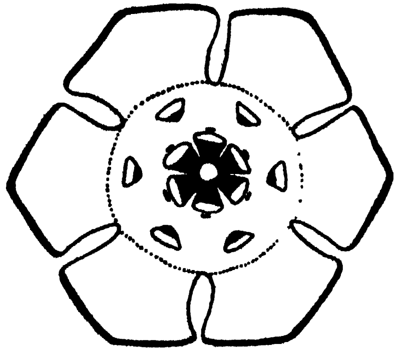


Fig. 10.
Diagram of a transverse section of the assimilating shoot of *Casuarina distyla*. All lignified tissue is shown black. The dotted line represents the limit of the chlorenchyma. Camera lucida outlines, ×16.

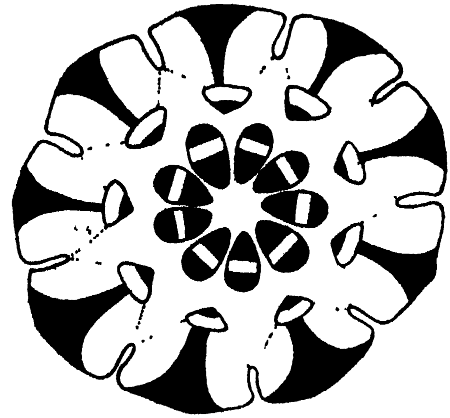


Fig. 11.
Diagram of a transverse section of the assimilating shoot of *Casuarina stricta*. All lignified tissue is shown black. The dotted line represents the limit of the chlorenchyma. Camera lucida outlines, ×16.

The shoot of *C. lepidophloia* is bounded by a moderately thick cuticle which extends about half-way down each furrow. The lower portions of the furrow are not thickly cutinised, and in this portion the stomates are arranged in usually four straight rows which extend down the whole length of the shoot. At the base of the furrow arise a few branched hairs. They are not numerous. The chlorenchymatous tissue is much reduced and occupies only a small space each side of the furrows. Between each chlorenchymatous group a mass of sclerenchymatous tissue is developed. The cortical region contains no parenchymatous cells save those of the medullary rays. In *C. distyla* and *C. stricta* there is a considerable parenchymatous cortex. The bulk of the cortex in *C. lepidophloia* is occupied by bast fibres. Running through the cortex from node to node are leaf traces, one opposite each rib of the shoot. The traces consist of collateral bundles of xylem and small phloem elements. Surrounding each bundle and extending to the base of each furrow lies a water transfusion tissue. These cells are approximately isodiametric, have cellulose walls, and are pitted on all their walls.

The conducting tissue occupies the central portion of the shoot. The xylem consists of spirally thickened and annular vessels. Secondary thickening had commenced in all shoots examined and the xylem formed a continuous band around the medulla. The phloem consists of small-celled elements with densely granular contents. The medulla consists of a tissue which does not appear to be described elsewhere in the Casuarineae. It consists of very thick-walled cells connected by numerous pits. The walls are lignified, and when seen in transverse section present somewhat the appearance of large fibres. In longitudinal section, however, it is seen that they are tracheidal in form and perform probably the function of water storage. In addition such a central tissue has a great mechanical advantage to a plant such as *C. lepidophloia* in which the switch-like shoots are continually exposed to a vigorous wind action. Interspersed with these tracheidal cells are a few cells containing tannin. In *C. distyla* the pith is slightly sclerised.

From this central tissue, medullary rays run through the conducting system, through the cortex, and terminate at the bases of the furrows. It is somewhat remarkable that every cell in the rays is full of tannin which stains a violet-black

with ferric chloride. The tannin in these cells, and also in *Geijera parviflora*, has a solid, glassy appearance. In some cases the tannin masses are broken and scratched by the microtome knife. This coincides with that structure which Lloyd (1922, *a* and *b*) has described in various species. From its occurrence in a definitive tissue such as medullary ray cells—the latter being the only parenchymatous tissue besides the chlorenchyma—it appears that the tannin performs some other function in the plant than that of an excretory product (*vide* Lloyd, 1922, *b*).

Geijera parviflora. (Figs. 12 and 13.)

The leaves of *Geijera parviflora* are linear, obtuse, and somewhat thick. There are practically no structural differences between the dorsal and ventral sides. The chlorenchyma consists of short palisade cells. A peculiar feature is the relatively large number of cells which contain tannin masses; these cells are scattered among the assimilatory cells from which they do not differ in shape. The tannin masses are, in most cases, broken and scratched by the knife, and appear to have shrunken away from the cell walls. No fresh material was available to examine its condition in the living plant (Lloyd, 1922, *loc. cit.*).

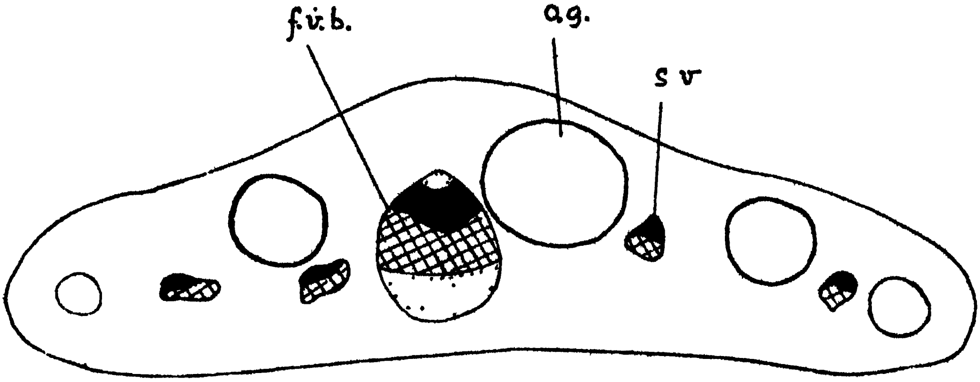


Fig. 12.
Transverse section of leaf of *Geijera parviflora*.
f.v.b., Fibro-vascular bundle; *o.g.*, Oil-gland; *s.v.*, Secondary vein. ×21.

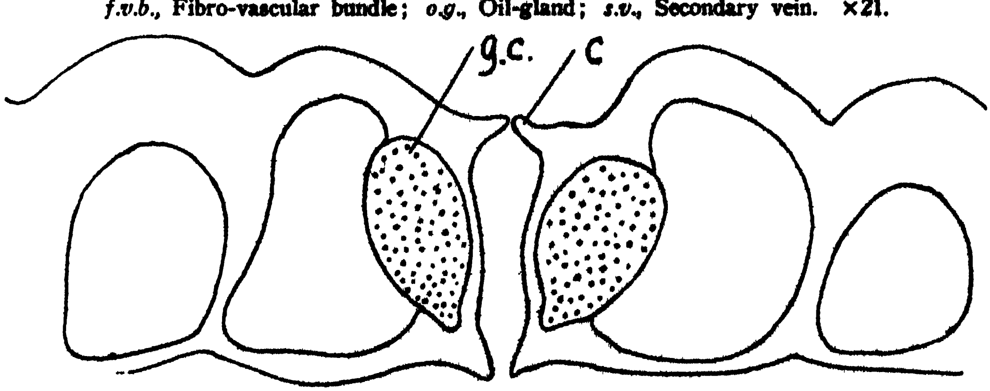


Fig. 13.
Transverse section through a stomate of *Geijera parviflora* showing heavily cutinised epidermal cells. *g.c.*, Guard cell; *c.*, Collar. ×760.

A characteristic feature of *Geijera parviflora* is the large oil glands which are found throughout the mesophyll. These are spherical and numerous. The midrib and secondary veins are simple bundles with relatively large phloem cells.

Little mechanical tissue is present in the leaf. The epidermis is composed of fairly large cells very heavily cutinised (fig. 13). The stomates are sunken below the general level of the epidermis, and the guard cells are protected by an upstanding collar formed by the projection of the cuticle of the adjacent epidermal cells. This appears as a ridge in fig. 13.

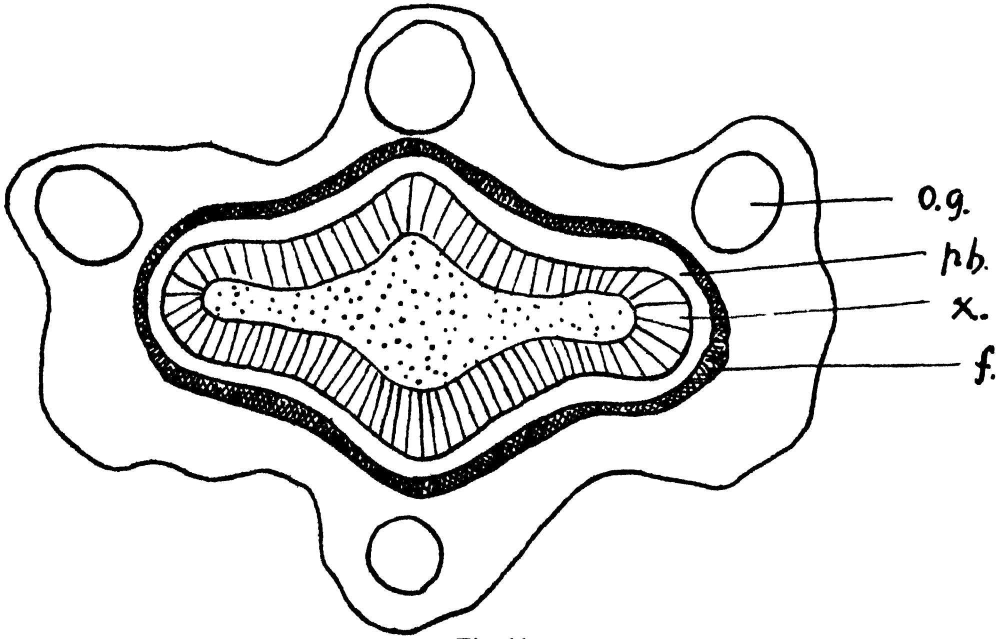


Fig 14.
Transverse section of stem of *Pholidia scoparia*.
o g, Oil gland; *ph.*, Phloem; *x.*, Xylem; *f.*, Fibres. ×46.

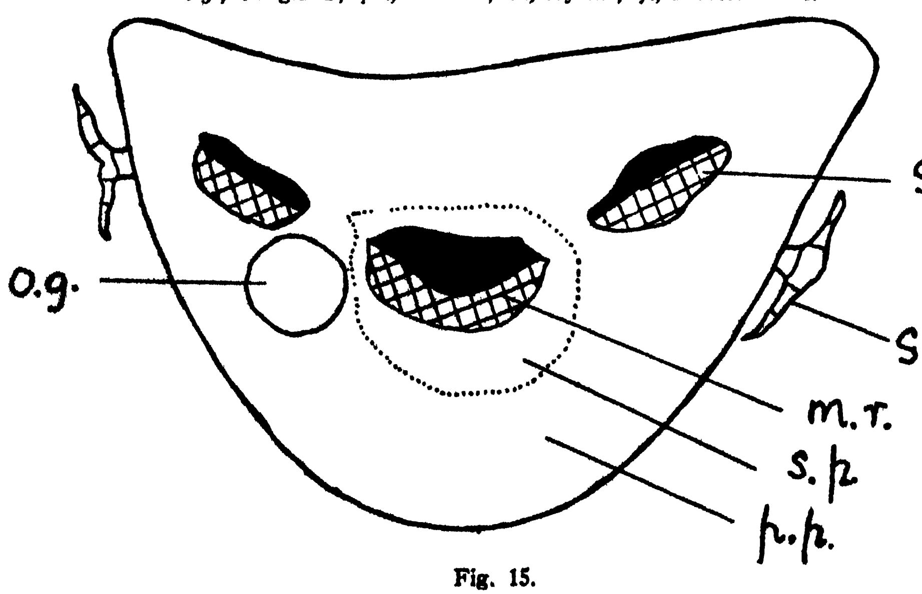


Fig. 15.
Transverse section of leaf of *Pholidia scoparia*.
s.v., Secondary vein; *s.*, Scale; *m.r.*, Midrib; *s.p.*, Spongy parenchyma; *p.p.*, Palisade parenchyma; *o.g.*, Oil gland. Only two scales are shown. ×27.

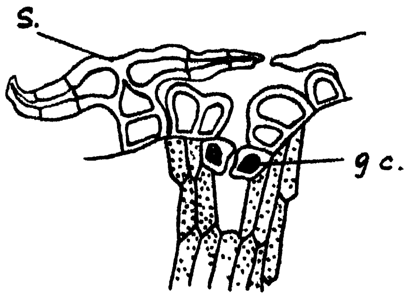


Fig. 16.
Transverse section through portion of stem of *Pholidia scoparia*, showing sunken stomate and protecting scale.
s., Scale; *g.c.*, Guard cell. ×94.

Pholidia scoparia. (Figs. 14, 15, and 16.)

Some of the features of *Pholidia scoparia* have been described by Cannon (1921) in his general survey of the genus *Eremophila.*

Pholidia scoparia is a "switch plant." The leaves are small, and the functions of photosynthesis and transpiration are undertaken by the stems also. As mentioned before, the areas of leaves and stem were calculated separately, and it was found that two-thirds of the total area was due to the stem. The stem in transverse section has roughly the form of a short cross (fig. 14). The epidermal cells are larger than those of *Geijera parviflora,* and also have their outer walls cutinised, though not so heavily. The stomates are simple guard cells sunken below the epidermis (fig. 16). No protecting ridges are developed. The surface of the epidermis is covered with scales whose heads overlap and protect the epidermis generally. Each scale is made up of a disc-shaped head supported on a short stalk attached to a basal epidermal cell. All the cell walls of the scale are thick and cutinised, and appear to have no living contents. The hairs have probably a purely protective function. They are more scattered on the stem than on the leaf. Calcium oxalate crystals are present in many of the epidermal cells.

The chlorenchyma is composed of rather small, regular, palisade cells and spherical, spongy parenchyma. Oil glands are developed in the mesophyll. These are smaller than in *Geijera parviflora.* The medulla is formed of large parenchyma cells containing a good deal of starch. The xylem entirely surrounds the medulla and comprises very small spiral, annular, and pitted vessels. The phloem has fairly large cells. A continuous sheath of phloem fibres surrounds the whole.

The epidermis and stomates of the leaf are similar to those in the stem, but the scales are more numerous. The leaf (fig. 15) has a central midrib with a little collenchyma developed beneath it. Two smaller veins occur lateral to the midrib. The chlorenchyma is mainly a ring of two rows of palisade cells with a little spongy parenchyma placed centrally. Oil glands are also present in the leaf.

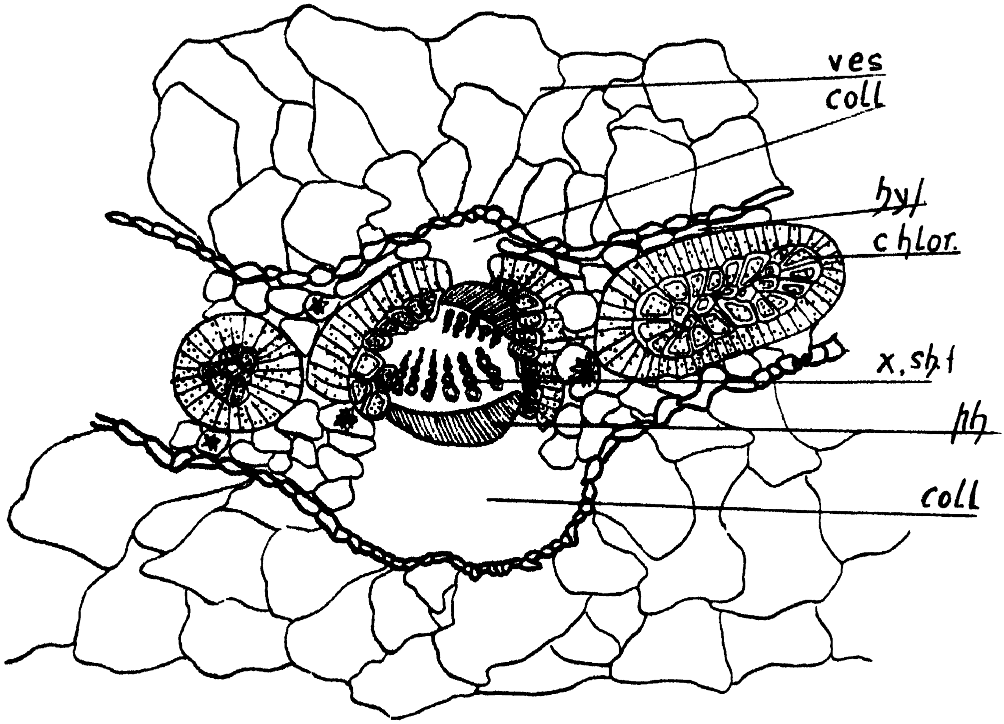


Fig. 17.
Transverse section through leaf of *Atriplex vesicarium*.
ves., Vesicles; *coll.*, Collenchyma; *hyp.*, Hypodermal layer; *chlor.*, Chlorenchyma; *x.*, *sh.f.*, Xylem and sheath fibres; *ph.*, Phloem. Camera and lucida outlines, ×31.

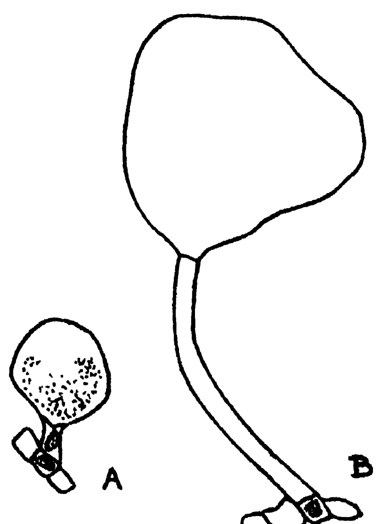


Fig. 18.
Water-storing hairs from young leaf of *Atriplex vesicarium*.
A, Young hair. B, Hair with stalk cell elongating. About ×250.

Atriplex vesicarium. (Figs. 17 and 18.)

The leaves of *Atriplex vesicarium* vary rather widely in shape from elliptical or oblong lanceolate to obovate and with entire or deeply indented margins. The epidermis consists of fairly small cells not cutinised, but with cellulose walls which are somewhat thicker than those of the mesophyll cells. All the epidermal cells have living contents. The stomates are simple guard cells placed on the same level as the epidermal cells and not protected by any projecting ridges. Underneath the epidermis on both sides of the leaf is a layer of rather large cells packed loosely together and containing no chloroplasts, but with clear watery contents and also many crystals of calcium oxalate. This is termed the hypodermal layer (fig. 17).

The midrib is composed of two vascular bundles, non-lignified fibres being scattered between both the xylem and phloem elements. Collenchyma is developed above and below the midrib. The margins of the younger leaves also have a strengthening collenchymatous tissue. Monteil (1906) describes *A. vesicarium* as having five vascular bundles in its midrib. The writer has examined leaves from several different plants of *A. vesicarium,* and in no case has he found this to be the case. It is doubtful whether Monteil was dealing with *A. vesicarium,* since he regards the leaf type as being near to that of *A. rosea.* In this species the mesophyll is not arranged radially around the nerve sheath, no hairs are developed, and no chlorenchymatous sheath is present around the midrib.

The midrib and secondary veins are surrounded throughout their whole length by a sheath of thick walled, practically cubical cells containing chlorplasts and very numerous starch grains. Surrounding these cells lies an outer sheath of thin walled palisade cells. They contain relatively little starch, from which it appears that the thicker walled cells around the veins have a collecting or storage function.

The epidermis on both dorsal and ventral sides is thickly covered with large bladder-like hairs. The cells have cellulose walls and a very thin lining of living protoplasm. In the older leaves these hairs are compressed to form a network as shown in fig. 17, the individual cells arising, to all appearances, from several epidermal cells and interlocking fairly tightly with few intercellar spaces. To determine the origin of these hairs a young leaf was taken from a bud and examined in transverse section. Hairs were found in all stages of development; they arise from a single basal epidermal cell, have a stalk cell and a single large terminal cell. All three cells at this stage have quite dense protoplasmic contents (fig. 18*a*). The stalk cell elongates (fig. 18*b*) and the bladder assumes considerable proportions. Later, it appears that the stalk cell degenerates and many of the large terminal cells become joined together by the union of their cellulose walls. These large cells are considered to function as water-storing vesicles.

In conclusion, it may be remarked that *A. vesicarium* bears a striking resemblance to *A. Halimus,* described by Volkens (1887) from the Arabian desert—an example of the similar structural modifications produced under similar conditions.

Rhagodia Gaudichaudiana. (Fig. 19.)

This plant is a weak shrub and usually straggles over other bushes. The leaves are hastate and their structure is comparatively simple. The mesophyll throughout consists of rather spherical cells containing plastids. There is no differentiation into palisade and spongy parenchyma. Large water-storing cells with clear contents are found irregularly scattered through the mesophyll tissue. These large cells usually contain crystals of calcium oxalate. The midrib and secondary veins are simple vascular strands. There is a little collenchyma developed underneath the midrib, otherwise mechanical tissue is lacking. The

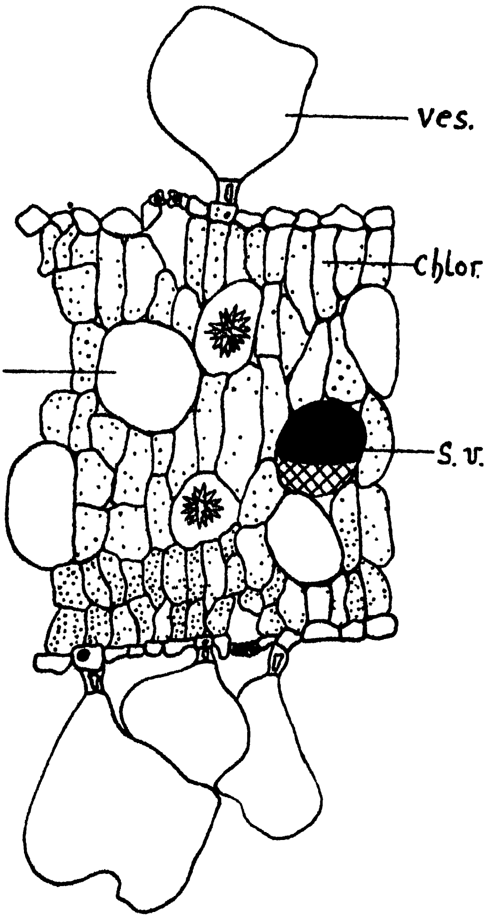


Fig. 19.
Transverse section through leaf of *Rhagodia Gaudichaudiana*.
ves., Vesicles; *chlor.*, Chlorenchyma; *s.v.*, Secondary vein; *w.s.c.*, Water storage cell. ×186.

epidermis consists of small uncutinised cells; the stomates are relatively numerous. They are small, undifferentiated, guard cells on the same general level as the rest of the epidermis. The epidermal hairs are of the same general type as in *Atriplex vesicarium*, but they differ from those of the latter in retaining their stalk cell when mature. Each hair consists of a basal epidermal cell with a large nucleus, a short stalk cell with thickened walls, and a large balloon-like terminal vesicle. The function of the latter is probably that of water storage.

Kochia sedifolia. (Figs. 20 and 21.)

The "bluebush," *Kochia sedifolia*, forms rounded bushes about 2 to 3 feet high. The leaves are approximately cylindrical and about one centimetre in length. *Kochia sedifolia* is a distinctly succulent type (fig. 20). The epidermis is uncutinised. Below the epidermis lies a ring of palisade parenchyma usually two cells thick. The central tissue is composed of large, irregular, water-storing cells free from chloroplasts, but often containing crystals of calcium oxalate.

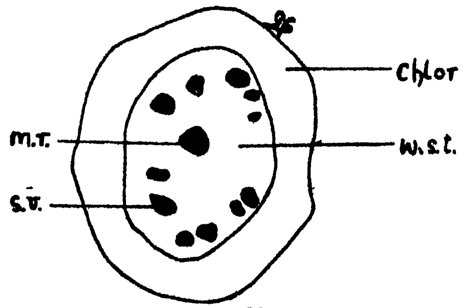


Fig. 20.
Transverse section of leaf of *Kochia sedifolia*, only a few of the hairs are shown.
chlor., Chlorenchyma; *w.s.t.*, Water-storage tissue; *m.r.*, Midrib; *s.v.*, Secondary veins. ×15.

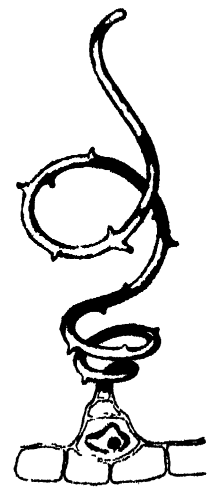


Fig. 21.
Absorbing hair of *Kochia sedifolia*. About ×300.

There is a central main vascular strand and secondary strands around the periphery of the water-storage tissue. No mechanical tissue, other than the xylem elements, is present.

The chief point of interest in *Kochia sedifolia,* however, lies in the peculiar type of water-absorbing hair which covers the epidermis. Each hair has a basal cell with a large nucleus. This cell is larger than the neighbouring epidermal cells and is partially buried in the assimilating tissue. The hair has a short stalk cell which also appears to have living contents, and a very long terminal cell. The latter cell has the spiral form shown in fig. 21. Near the base it usually makes a few turns in the form of a compressed spiral, which becomes much looser towards the terminal end. The cell has many small branches on its wall. These usually project upwards toward the terminal end of the cell. The cell has very thick cellulose walls and is non-cutinised. A narrow pore runs the length of the cell. There are no living contents. The individual hairs are much intertwined, so that the whole surface is covered with a thick felt of dead cells. The function of these hairs is that of water absorption. The dead, air-containing cells probably act as capillary tubes up which the water is drawn to the living basal absorbing hair, and from which the water enters the leaf by osmosis. Such spiral hairs do not appear to have been described in the Chenopodiaceae, although they have been observed (without projections) in certain members of the Compositae—as, for example, in *Espeletia* (Haberlandt, 1914). The peculiar small branches on the terminal cell have been described in other members of the Chenopodiaceae, *Chenopodium muricata* and *Enchylaena tomentosa* (Monteil, *loc. cit.).*

DISCUSSION

Having described the structural modifications found in the shoots, we are now in a position to attempt an explanation of the types of transpiration curves in the light of these modifications. Before so doing, attention must be drawn to the calculations of Brown and Escombe (1900), who showed that the actual maximum diffusion of water vapour from the leaf of *Helianthus* was only one-sixth of the possible maximum diffusion calculated for the number and size

of the stomates, and these conclusions were supported by Lloyd (1908) in his observations on *Fouquieria splendens.* Consequently it is only when the stomatal opening is nearly closed that stomatal regulation can have any effect upon the transpiration rate. This is exemplified in the case of *Casuarina lepidophloia.* During the day the transpiration curve of this plant closely approximates that for the evaporating power. This is intelligible since the stomates in the furrows are but little protected by the few hairs which are developed. High winds have little difficulty in sweeping along the lines of stomates in the furrows of the vertically placed shoots that bend before them. The lack of agreement of the transpiration with the evaporation curve during the night is ascribed to stomatal control. Livingston (1906) has found similar curves for *Euphorbia capitella,* a xerophytic Arizonan plant; here the day curves for transpiration approximated that for evaporating power, whilst a lack of agreement occurred at night.

The plants in the second group—*Geijera parviflora* and *Pholidia scoparia*—show their transpiration maxima at the same time as the evaporation maximum, but the curves are much flatter, *i.e.,* they do not respond readily to variations in evaporating power. This reduction is ascribed in both cases to the presence of oily secretions, the vapors of which materially reduce transpiration. Further protection is afforded by the ridge in *Geijera parviflora* and by the scales in *Pholidia scoparia.*

The plants *Atriplex vesicarium, Rhagodia Gaudichaudiana,* and *Kochia sedifolia* have a thick covering of vesicles or air cells. The vesicles of *Atriplex* and *Rhagodia* contained little water at the time of our visit, as comparison with the turgid hairs shows; in *Kochia* the terminal cells contain air only. We have, therefore, a very efficient air jacket surrounding the whole of the leaf surface. Hence, near the epidermis we have a set of conditions which are constant and unaffected by external factors. Under these conditions the plant transpires regularly, equal amounts of water in equal times, since only the water vapor which gradually diffuses to the surface of the hairs comes under the influence of the external factors and is swept away. This explains the straight-line transpiration curve obtained in these plants. The greater insulation of *Kochia* with its thick felt of hairs is shown in the greater length of curve parallel to the time axis. The fall during the night is ascribed to the more or less complete closure of the stomates and the variations from the curves for the external factors (for example, the second maximum exhibited in most cases from 8 to 9 o'clock) to the regulation of the transpiration by "physiological" control of the stomates. It must be admitted that the term physiological control has been used by many writers as a cloak to hide our ignorance of some of the factors concerned in the mechanism of stomatal regulation, especially during the night. Since we cannot logically ascribe it to "vital" action of the cells, it is probably due to changes in the turgor of the guard cells produced by the action of enzymes on the carbohydrates, or possibly to changes in pressure of the water vapour in the intercellular spaces of the leaf; that is, internal factors which were not determined in this research.

In conclusion, my thanks are due to Mr. Lisle G. Johnson, owner of Dilkera, for his kindness in affording facilities to conduct this work there, and especially to Professor T. G. B. Osborn for his constant help and encouragement which made possible the progress of this research.

Summary.

1. The transpiration rates of *Casuarina lepidophloia, Geijera parviflora, Pholidia scoparia, Rhagodia Gaudichaudiana, Atriplex vesicarium,* and *Kochia sedifolia* are measured and discussed in relation to the external factors influencing transpiration.

2. The methods of measuring transpiration, evaporating power of the air, relative humidity, and light intensity are described.

3. The anatomy of the shoots is discussed from a physiological standpoint. A water-storage tissue in the Casuarineae and a type of hair in the Chenopodiaceae hitherto undescribed are recorded.

4. An attempt is made to correlate the transpiration rates with the anatomical modifications of the leaves.

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DESCRIPTION OF PLATE XXI.

Fig 1. Battery of potometers on stand. The plants from left to right are *Atriplex vesicarium, Geijera parviflora, Casuarina lepidophloia, Pholidia scoparia, Kochia sedifolia, Rhagodia Gaudichaudiana*. The atmometer is shown on the extreme right of the stand and the thermometer on the left.

Fig. 2. Shows the situation in which the work was carried out. The shrubs are chiefly *Kochia sedifolia*, and *Acacia* spp., with a little *Atriplex vesicarium*. The trees are *Myoporum platycarpum* and *Casuarina lepidophloia*. Mallee scrub can be seen in the distance.

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A GEOLOGICAL SKETCH-SECTION OF THE SEA-CLIFFS ON THE EASTERN SIDE OF GULF ST. VINCENT, FROM BRIGHTON TO SELLICK'S HILL, WITH DESCRIPTIONS.

By Professor Walter Howchin, F.G.S.

[Read September 13, 1923.]

Plates XXII. to XXVI.

CONTENTS.

A few places of special geological interest and of easy access, on the eastern margin of Gulf St. Vincent, have been carefully examined, especially for fossils, and a considerable literature exists in relation to the same; but, hitherto, there has been no attempt to give a consecutive and complete section of what must be regarded as one of the most interesting combinations of geological features to be found in the southern portions of the State.

The geological systems that appear in this line of section include the Cambrian, Permo-Carboniferous (glacial), various Tertiary horizons (both fresh-water and marine), Pleistocene and Recent.

With respect to the nomenclature of the Tertiary systems of South Australia, the late Professor Tate classed the older marine series ["Aldingan," etc., Victoria="Janjukian"] as of Eocene age; and the newer marine series, as of Miocene age. Mr. F. Chapman and Professor J. W. Gregory, following the late Professor McCoy, consider Tate's Eocene to be of Miocene age, and Tate's Miocene to be Lower Pliocene (Chapman, F., 1914). This revised classification has been followed in the present paper.

To the northward of Marino (near Brighton) no beds older than Recent are exposed along the coast. The shores are low and fringed by sandhills and mangrove swamps which continue to the head of the Gulf, giving evidence of recent elevation of the shoreline to the extent of about 16 feet.

SUB-SECTION A.

BRIGHTON (BORE) TO BLACK POINT (4½ MILES).

The township of Brighton is situated near the southern boundary of a great faulted earth-block which has had a downthrow of at least 4,000 feet. A great pit of such a depth would have existed where Adelaide stands had it not been filled up to the extent of over 2,000 feet, partly by deposits from repeated incursions of the sea, and partly by the perpetual wash of clay and stones from the higher ground.

The Adelaide platform (which forms one of the ledges in the successive subsidences of the ground towards the centre of the great rift-fault of the Gulf) is in the form of a curve, having its convexity towards the hills with a south-westerly trend that reaches the coast at the Marino Rocks. This westerly curve of the hills to the sea supplies very definite evidence of earth fracture. Had this curve in the hill country been caused by a tectonic twist it would have changed the strike of the beds and the Mitcham quartzites would have been continuous in outcrop to the coast. But this is not so; the strike continues in an approximately north and south direction, and newer beds in the succession form the outcrops to the coast, being truncated and cut off on their northern edges by the faulting.

A boring for water at the Institution for the Blind, Deaf, and Dumb, a little north of Brighton township (Sec. 238), carried out by Morrison, Gray and Co., passed through alluvium to a depth of 223 feet, when, after 2 feet of limestone, the bore entered "marine limestone with shells," which was penetrated to a further depth of 79 feet. Another bore, situated a little to the southward of the above mentioned, on the grounds of late Rev. A. Macully, passed through similar beds. The material was sandy (mostly unconsolidated) and carried an abundance of the large foraminifer, *Operculina complanata*, which is a very characteristic fossil in the Muddy Creek beds, Victoria. Age: Janjukian (Miocene). As a bed of fossiliferous Lower Pliocene (Kalimnan) occurs on the scarp of the older rocks, within a short distance to the southward of Brighton, and at a height of 40 feet above sea level, the throwdown of the Brighton section is thereby evidenced, and probably represents the same faulted segment that was proved in the Croydon bore.

The foreshore between Brighton and Seacliff (about a mile) forms a long slope with shallow water to seaward and bounded, on the landward side, by low sandhills that rest upon a floor of recent clay a few feet above sea level. This clay floor bears up the drainage from the sandhills, giving rise to a series of springs near the base of the cliffs on the seaward side.

At Seacliff, the clay beds displace the sandhills and form the main cliffs. At the latter township a road has been cut down through the alluvial beds to the beach, giving a complete section of the same; mottled clays and gravels at the lower levels, and newer reddish clays on top. Cliffs of this type continue for more than a mile. There is a low platform between the cliffs and high-water mark, varying from 50 yards to 100 yards wide, and is built up of similar materials to that of the cliffs. There are no evidences of marine exuviae on this flat, which appears to have been formed by the action of the rain on the face of the clay beds together with small alluvial fans brought down by rivulets which run during seasons of rain.

About a quarter of a mile to the southward of Seacliff railway station there is a very extensive washout, caused by a very small runner that has excavated a canyon, having vertical sides of over 20 feet in height. This work of erosion has been accomplished within the years of European settlement.

Towards the end of the clay banks, on the sea front, the lower platform changes its character; instead of clay, sand, and grass, there is a platform composed of very large sea-worn boulders that is now about 5 feet above high tides.

Cambrian Rocks in Section A.

The first evidence of the older rocks outcropping on the coast occurs where beds of Cambrian age show themselves in the cliffs opposite to the Marino railway station. These beds form part of the faulted segment which, inland, form the platform on which Blackwood and Belair are situated, and is next above the sunken Adelaide segment. No beds of the (older) Adelaide Series reach the coast within the area now under description, but the "Brighton limestones," which form the topmost members of that Series, make a line of outcrop on the rise, about half a mile from the coast, and can be traced southward to the River Onkaparinga, where they cross the latter about a mile, up-stream, from Noarlunga. The junction of the Adelaide Series with the Cambrian beds can be seen along the line of excavation in the quarries of the Brighton Cement Company's works. The limestones have a thrust to the westward and roll on the dip, as well as pitch on the strike, in a succession of anticlines and synclines, and are, finally, thrown down to the west, in an almost vertical position with the purple slates of the Cambrian, in superior order, and, apparently, stratigraphically conformable with the limestones.

The sea-cliffs at Marino Rocks consist of purple slates that are interbedded with thin, reddish quartzites and limestones, having a strike almost parallel with the coast. The great westerly thrust has caused meridional folding, often reaching a high angle of dip. The parallel strike which the beds have to the beach, together with the high angle of dip, makes a weak structure of resistance against the action of the sea, which, in places, is making rapid encroachments. This is well seen at Black Point, at the northern end of Hallett's Cove, where the western limb of an anticline in the purple slates has become undermined, so that large segments of the rock face slip down to the beach by the force of gravity, littering the beach with great cubical masses of rock. On the southern face of the point the sea has made a breach through the anticline, exposing a fine transverse section of the folds, and has excavated the centre of the anticline so as to form a cave. It is here seen that the anticline has been fractured along the axis of the nip.

At the same place excellent illustrations of horizontal slickensides *(blatter)* occur, caused by rock movement. Finely-laminated layers of chloritized quartz have formed along the planes of movement, the laminae showing by the varying directions of the striae, the differential movements that have taken place in the process of folding and thrust.

A gritty limestone, of a very persistent character, occurs in the purple slates near the base of the series. It does not appear in the sea-cliffs, as its line of strike is a little inland—parallel with the coast. It can be seen exposed in the gullies near Marino, also at Hallett's Cove, and is extensively developed near Noarlunga, where it is quarried for road metal. It also occurs about the same geological horizon on the western side of Spring Creek, Mount Remarkable, as well as near the east and west fault at the south-eastern base of the last-named mount.

Permo-Carboniferous (Glacial) Rocks in Section A.

The glacial features of Hallett's Cove need not be described here, in detail, as they have been dealt with elsewhere (Tate, Howchin, and David, 1895; Howchin, 1895). They cover an area more extensive than the Cove itself, capping the cliffs both north and south of this break in the coastline, and are also exposed in the banks of creeks adjacent to the Cove.

On leaving the Hallett's Cove railway station, a walk of about a quarter of a mile across the paddocks (passing some farm buildings in ruin on the way) brings us to the top of the sea-cliffs. Near the edge of the cliffs a very siliceous quartzite forms the outcrop, and although much broken and weather-flaked, still shows some fine faces of glacial polish and striations. Resting on this glaciated floor, on the landward side, is a bank of boulder clay, containing numerous erratics. This marks the most northerly point where the evidences of Permo-Carboniferous glaciation can be traced, the glacier path being here directed seawards in a north-westerly direction.

Immediately to the southward of this place, a small gully, running in an east and west direction, finds its outlet on the beach. Standing on the right bank of this gully, near its outlet, a rather remarkable section can be seen on the opposite bank (Howchin, W., 1918a, fig. 307, p. 411). In the bed of the stream and lower portions of the bank the Cambrian quartzites make a distinct anticline, causing a small waterfall. Resting unconformably on this Cambrian floor, which is well polished, is the glacial till [1] with its striated erratics, of Permo-Carboniferous age. A further unconformity occurs by the fossiliferous Lower Pliocene resting on the boulder clays; while a still further unconformity arises from the Pliocene beds being covered by clays, sands, and a thick bed of nodular travertine of Recent age, making three stratigraphical unconformities in a section of about 80 feet in thickness. These respective beds can be traced up the small gully (referred to above) and its tributaries for about a quarter of a mile, where they run out against the Cambrian boundary.

Crossing the small gully, at the waterfall, and climbing the bank of till on the opposite side, at a distance of about 100 yards, the largest exposed face of the glaciated floor in the locality is seen on a rather steep slope towards the beach. The smoothed rock forms part of the Purple Slate Series, and has taken a high polish with many broad groves and fine scratches which have a north-westerly direction (Howchin, W., 1918a, fig. 308, p. 412). Some of the latter give evidence of ricochetting by the stones forced along by the glacier and repeatedly digging into the floor, in a series of jumps, with the deeper side of the cut in the direction of the flow, like a jumping chisel, and thus establishing by the clearest proofs the direction in which the glacier was travelling. Other, but smaller polished faces, have become exposed by the denudation of the overlying beds near the extremity of Black Point, and are also seen wherever the clay has been removed so as to expose the underlying glacial floor.

The till, or boulder clay, resting on the Black Point shelf, is a relatively thin deposit, averaging about 20 feet in thickness, and does not contain such very large erratics as are scattered over the Cove and on the southern side of the outlet of the Field River, but it has yielded some scores of strongly glaciated stones from the till. The relationship which the glacial beds have to the fossiliferous Pliocene was, for some time, a question of discussion, but was set at rest by an excavation, carried out under the auspices of the Australasian Association for the Advancement of Science [Report, 1895], when by a costean pit it was proved that the boulder clay passes beneath the Pliocene beds. This inferior position of the till to the Pliocene is also clearly shown in a section near the head of the Cove.

The glacial clay on the Black Point platform contains numerous nodules of sandy crystals of barytes, the sand having been included in the barytes in the process of crystallization. These nodules are usually from an inch to an inch and a half in diameter. The crystals are grouped round an axis of growth

(1) The term "till" is here used in preference to "tillite," as the Permo-Carboniferous glacial beds of South Australia are invariably soft and friable, as in the case of modern glacial deposits.

with polar extremities. The outcrop extends for about eight chains (Mawson, 1907).

Lower Pliocene Rocks in Section A.

The fossiliferous Lower Pliocene beds probably at one time formed a continuous deposit resting on the older rocks that occupied the area of the present Gulf and its margins. They are now found only in isolated patches, one of the largest of these comprises the flat knoll on which Adelaide is built. Formerly, they were exposed on the banks of the Torrens (where the engine houses have been constructed) and also in quarries that were worked behind Government House.

The first appearance of the Lower Pliocene beds on the coast is in a small washout, situated directly westward of Marino railway station, where a fossiliferous sandstone of this age forms the lip of a waterfall. It occurs near the extreme northerly limits of the Cambrian outcrops of the neighbourhood, and is exposed to the extent of only a few square yards. The bed is, for the most part, a breccia, resting on the edges of Cambrian grits that have a dip of 80° to the westward. Fossils are not very plentiful in the bed and are patchy in their occurrence. The species determined are as follows:—

Cominella subfilicea, Tate	*Diastoma provisi*, Tate
Natica subvarians, Tate	*Montlivaltia variformis*, Dennant

Sandy patches occur, in places, on the top of the cliffs which may be residuals of the Lower Pliocene, but no clearly defined deposits of this age are found to the southward of the Marino outcrop till we come to the calcareous plateau on the northern side of Hallett's Cove. Here the fossiliferous Lower Pliocene beds rest on the glacial boulder clays, making a steep scarp, facing the sea, and, together with the more recent beds, form a retreating cliff on the top of the primary cliff consisting of Cambrian slates.

The beds have been much leached of their lime content and the fossils occur, mostly, as impressions and casts. Small nodules of *Lithothamnion* are moderately common. The beds are thickest at their most northerly position, where they form a scarp behind the principal exposure of the polished pavement, and can be traced, inland, to a distance of about 200 yards from the sea-cliffs.

Pleistocene Rocks in Section A.

Mottled Sands and Clays.—These form the lowest of the three classes of rock which occur, locally, as subsequent formations to the Pliocene. They can be distinguished by their strongly mottled colouring, in patches of red and grey, varying in composition from a tough plastic clay to that of an argillaceus sand rock, and possessing considerable coherence by which they can maintain vertical and wall-like faces though exposed to the weather. They make a typical rock formation that is widely distributed, not only in the sections seen on the coast, but in inland situations, and at various elevations. They occur on both sides of the Gulf, making a very striking feature at Ardrossan, where they form vertical sea-cliffs 40 feet in height (Howchin, 1918b). They are of freshwater origin and sometimes contain impressions of leaves. They are often associated with the older river systems and are probably of Pleistocene age.

Between Marino and Hallett's Cove these mottled sands and clays can be seen, in many places, resting on the top of the purple slates and also in the railway cuttings, where they are sometmes associated with indurated gravel beds.

Recent Deposits in Section A.

Reddish Clay.—The coastal plains and open valleys (especially those having a north and south direction) usually carry a considerable thickness of alluvium.

It is, typically, a stiff loamy clay, which makes a good brick earth, but varies, in places, sometimes taking the form of a light loam, and, at others, a marly loam, or passes into sand and gravel. These Recent alluvia often occur overlying the mottled beds and can be distinguished from the latter by their uniform colouration (sometimes greenish), less compact form, and often by a plane of erosion; the reddish clays not infrequently fill in gutters that have been excavated by stream action in the older mottled clays, as can be seen in the cliffs at Ardrossan (Howchin, W., 1918b) and also on the eastern side of the Gulf, references to which will be given later.

These Recent clays can be studied in the cliffs near Seacliff and Marino, where a washout, caused by a small runner, has developed within recent years a considerable canyon which extends from the beach almost to the railway line.

Both the mottled clays and the newer reddish clay show horizontal and truncated bedding at a considerable height above the present sea level, giving evidence that they were laid down, either before the present valley of Gulf St. Vincent was invaded by the sea, or at a time when the sea margin was more remote than it is at present.

Nodular Travertine.—This is a concretionary and chemically formed limestone which is a common surface feature throughout the district where the subsoil is calcareous. In the lower portions of the bed it is a marly clay, becoming more nodular and limy in its upper portion, and often forms a limestone crust, or sheet, near the surface. It is well developed at the Cove, varying in thickness from 6 feet to 15 feet. At the north end of the Cove, at the back of the principal ice-polished face, it makes a scarp and is very nodular in structure.

SUB-SECTION B.

BLACK POINT TO ROCKY POINT (3¾ MILES).

Black Point, as already described, forms the northern headland to the broken coastline that goes under the name of Hallett's Cove. The Point consists of very dark-coloured purple slates, of Cambrian age, so that, when seen from the seaward it has a very black and forbidding aspect, which has given rise to its name. The prominence which the rocks make at this point affords an excellent cross section of the beds, showing an acute anticlinal fold that is fractured and slipped on the axial plane.

Hallett's Cove, as a whole, forms one of the most picturesque spots on the coast within the limits of Gulf St. Vincent. It is scarcely a Cove in the ordinary acceptation of the term, as there is no sheltered area of sea space and only a slight indentation on the coastline. The Field River, which finds its outlet at the Cove, is only a creek that can easily be stepped across, and has no inlet from the sea, except at very high tides. The Cove is a natural amphitheatre of broken ground, bounded by rocky headlands. It owes its existence not to marine erosion, but to the effects of rain beating on the exposed faces of soft rocks and the transporting agencies of small runners that excavate channels in the soft material.

Cambrian Rocks in Section B.

There is no outcrop of Cambrian rocks within the amphitheatre of Hallett's Cove itself. A large mass of purple rock, 12 feet in length, exposed near the head of the amphitheatre was, at first, thought to be an inlier of the older rocks, but by the removal of the soft material by subsequent erosion it was seen to be an erratic in the till, and is now fallen apart in two pieces. The Cove is, however, bounded by Cambrian slates and quartzites on the landward side. Good sections are exposed in the creek that reaches the sea a little to the northward of Black Point, and also in the Field River, near the southern extremity of the Cove, as well as in a small creek a little to the northward of Field River.

The Field River, in its lower portion, cuts the beds transversely and supplies some excellent geological sections. At a distance of about half a mile from the coast a very striking overfold occurs in the left bank of the stream in the form of the letter S (Howchin, W., 1904, pl. xxxviii.), and, a little higher up the stream, the junction of the lower and upper series of the Palaeozoic rocks can be seen. The Brighton limestone and associated beds are thrown down to the west at a high angle of dip (as in the section at the Brighton quarries) with the purple slates in superior order. Rising from beneath the limestone are the impure siliceous limestones which, at about a mile from the beach, form a commanding anticline, 100 feet in height (Howchin, W., 1904, pl. xxxvii.). A curve in the stream at this point shows that the beds also roll on the line of strike, forming anticlinal folds at right angles to the great anticline just described.

The main limestone makes a remarkable curve in its outcrop where it crosses the Field River. From Brighton to Field River it follows a north and south strike, but on reaching the stream, just mentioned, it curves to the eastward and follows the left bank of the river till within about a mile of Reynella, where it is faulted to the right bank, and at Reynella it resumes its approximate north and south direction. In Sec. 521, a little east of the fault, just mentioned, the stream cuts the beds, for a short distance, at a right angle, and as the beds are not so highly pitched here as they are further to the westward, an excellent opportunity occurs for studying the junction which the Adelaide Series makes with the Purple Slate Series at this point; the uppermost limestones of the former pass up, gradually, into the purple slates of the latter.

On the southern side of Field River the Cambrian purple slates (interbedded with thin reddish quartzites) form the main sea-cliff, reaching a maximum height of about 80 feet, and as the strike of the beds accords, approximately, with the direction of the coast, the cliffs form nearly a straight line, and no special rock features are brought into view for a considerable distance. The beach, however, forms an excellent example of a marine platform, cut back by the waves, with the truncated edges of the highly-pitched Cambrian beds standing up in serrated ridges, like the furrows of a ploughed field. At a short distance south of Hallett's Cove a fine example of a ω-shaped fold (occurring along the strike of the beds) is seen on the beach (Howchin, W., 1918a, fig. 104, p. 118). The best view is obtained from the top of the cliffs where the outlines of the complex fold can be taken in at a glance. Southward from Hallett's Cove the Cambrian beds maintain a comparatively even face (on the strike) forming prominent cliffs. The exposed face forms the western limb of a rather acute anticlinal fold, with a high pitch.

At a distance of about one and a half miles from the Cove, a headland known as Curlew Rock (or Curlew Point) occurs. It is situated near the east-west district road that separates Secs. 581 and 577, Hundred of Noarlunga. On the southern side of the headland the sea has cut back the Cambrian beds for a considerable distance and has left the Curlew Rock as a semi-detached fragment at the angle of divergence in the cliffs, and exposed a transverse section of the folds that makes one of the most striking rock features along the coast (Howchin, W., 1904, pls. xxxix. to xl.). The rock consists of numerous alternations of thin purple quartzites with slaty partings that have become contorted in a most intricate fashion. The beds are in vertical position and the flexures, which by weathering have been brought into strong relief, are defined with the greatest detail. The folding can be studied in two directions—in the direction of the dip, in the headland; and in the direction of the strike, on the beach, which is clear of sand, and shows the truncated edges of the Cambrian rocks.

From Curlew Point, going south, the Cambrian quartzites and slates form a nearly vertical cliff, about 50 feet in height, in nearly a straight line, but are set somewhat further back than those to the northward. The close relation which rock structure bears to coast features is well illustrated here. The cliffs are composed of alternating beds of soft and hard rocks in a strike that is nearly parallel with the coast, having a high pitch (65° to 90°), and a dip slope facing the sea, a form of rock structure which makes it easy for the waves to undermine each layer in turn, and when thus undermined, the whole face slips down by gravity to the beach. This explains the straight line of cliffs, their steep and inaccessible face, and supplies the reason why the cliffs, at this point, have been worn back at a quicker rate than the adjoining sections. This rapid retreat of the cliffs has led to the formation of an extensive sea platform which is uncovered at low water. Standing at Curlew Point and looking southwards, the truncated edges of the Cambrian beds are seen in detail, giving evidence of tectonic compression having acted opposed to the strike of the beds, contorting the same in a transverse direction. As often occurs in the Purple Slate Series, the beds very commonly show the phenomenon of ripple marks. Towards the end of this straight face of cliffs, at a distance of about half a mile from Curlew Point, a sea-stack forms a conspicuous feature (Howchin, W., 1918a, fig. 98, p. 114).

At the end of this straight line of cliffs, an angle occurs in the direction of the latter, causing a slight easterly trend that brings in new features. At a short distance from the sea-stack the line of cliffs is broken by a curved recession, forming a shallow valley that is grass-grown and protected from the sea by low sand ridges. The Cambrian slates are here decomposed, dipping easterly, at a lower angle. Similar beds are seen on the beach, with a westerly dip, indicating an anticlinal fold.

On the southern side of the small cove, just described, the cliffs rise to a considerable height, with an easterly dip, capped by a layer of the fossiliferous Pliocene, and is followed by another slight indentation in the cliffs enclosing a grassed valley. The southerly side of this indentation shows a broken face of very siliceous quartzite, lithologically similar to a prominent outcrop that forms ridges on the beach. The falls from the cliffs, added to the outcrops on the shore, make an excessively rough beach, ending in a prominent "stack" at what may appropriately be called "Rocky Point" (opposite Secs. 616, 617). The latter has a dip east, with a slight curve at its summit, directed towards the west, forming a segment of an anticlinal arch. The stone is typical of the thicker quartzites of the Cambrian in being light coloured, very fine in the grain, and highly siliceous, examples of which can be seen near the summit of Sellick's Hill and in many localities in the Flinders Ranges; it is very distinct from the quartzites of the Cambrian in being light-coloured, very fine in the grain, occupies the beach in high serried lines and pinnacles with a dip east, 10° south, at 53°, and a strike from north-east to south-west, which soon takes it below sea level. Overlying these very siliceous quartzites are soft purple slates standing at a high angle and contorted. A little north of this point is a ferruginous conglomerate that rests on truncated Cambrian slates. The origin of this conglomerate was not investigated, but is probably a metasomatized form of the Lower Pliocene sandstones.

Permo-Carboniferous (Glacial) Beds in Section B.

Hallett's Cove, as a depression in the older rocks, owes its existence, primarily, to an over-deepened portion of the ancient glacial valley. The two headlands, forming the northern and southern boundaries of the Cove, are about a mile apart, and consist of dark-coloured purple rocks of Cambrian age.

The interval between these headlands has been excavated to an unknown depth and filled up with morainic material to a height of 100 feet above sea level, with overlaps on the Cambrian rocks at either side of the Cove. This morainic material, together with more recent deposits overlying it, has yielded more readily to atmospheric waste than the harder Cambrian rocks of the locality, giving rise to a retreat of the cliffs and much broken ground within the area, and has exposed some very large erratics. Near the head of the Cove there are two large cuboidal erratics, belonging to the siliceous limestones of the Tapley's Hill Series, situated close together, and, unitedly, measure 9 feet in length.

In the lower positions, within the Cove, the ground moraine, or till, is the leading feature; and, at the higher levels, in addition to the boulder clay, there are fluvio-glacial deposits in the form of fine-grained mud, sands, and gravels. The latter features are well developed on the sea face, towards the southern side of the Cove before reaching the Field River. Many of the stones in these beds are well scratched. So far as observed, the polished floor is limited to the cliffs on the northern side of the Cove. The Cove ends on the southern side with a thick body of boulder clay banked up against the Cambrian purple slates.

Some very large erratics occur on the beach, where they are more or less either obscured, or exposed, by the varying amount of sand left by the waves. Towards the Field River, and between tides, there are about half a dozen large erratics gathered from the Cambrian (or (?) Proterozoic) tillite which are grouped together; and on the beach, to the southward of the Field River, is the largest granite erratic of the vicinity, measuring 8 feet in length, of the Victor Harbour type, and is surrounded by a great field of erratics, of many kinds, and some of exceptional size.

The erratics contained in the till at Hallett's Cove give us some clue to the respective routes by which the ice travelled to the Cove. Among the travelled stones are numerous porphyritic granites from Victor Harbour district, which probably came by the Inman Valley, and, passing over the water parting of the Bald Hills, united with the main glacier near the site of Normanville. The fine-grained schists that form the lower cliffs of Cape Jervis are also well represented, and many of them are strongly glaciated. Rocks that outcrop nearer to Hallett's Cove—the impure siliceous limestone and the older moraines of the (?) Cambrian tillite, that occur between the Field River and the Onkaparinga—have been quarried out and transported by the ice-plough and form some of the largest of the erratics both on the beach and within the limits of the Cove. Some of the boulder clay, near the head of the Cove, is of a deep purple colour, having been ploughed up from the outcrops of the purple slates in the immediate neighbourhood—no more definite proof of the nature of the glaciation, as land ice, could possibly occur than these examples of local erosion. The Victor Harbour granite and the Cape Jervis schists that were delivered at Hallett's Cove indicate glaciers of not less than 50 miles in length.

The evidences of glacial action do not extend far beyond the southern limits of the Cove. Some particularly large erratics of the impure limestones that underlie the Brighton limestones occur on the beach, to the southward of the Field River, some of which are speckled with veins of calcite, and what is probably the largest erratic of the locality, also belonging to the impure limestone series, occupies a conspicuous position on the edge of the sea-cliff, about half a mile to the southward of the Cove. Its present position is suggestive of a "perched block," but when this great erratic was stranded on the retreat of the ice, the cliff in its present form, of course, did not exist. Near to this large erratic the glacial evidences of the neighbourhood appear to end.

The glacial remains at Hallett's Cove form a small outlier of a much more extensive glacial field that is in evidence further to the southward. It embraces the Cape Jervis peninsula south of the Willunga Ranges, the Inman and Hindmarsh Valleys, Encounter Bay, the Mount Compass and Finniss River districts, southern Yorke Peninsula, and parts of Kangaroo Island. The glacial beds underlie the Lower Pliocene at Hallett's Cove, and also the Miocene in southern Yorke Peninsula and in Kangaroo Island; they rest upon either the Cambrian or Pre-Cambrian in all cases where their base is shown. At the time of the ice-flood the present drowned valley of Gulf St. Vincent was an upland valley that held the main glacial stream, into which the tributary glaciers of the Inman and other valleys, situated both east and west of the main glacier, delivered their quota. Or if the ice was in the form of a continuous sheet, which is probable, then no such valley need to be assumed.

That the Permo-Carboniferous glaciation extended much further to the northward than Hallett's Cove is probable from the extent of the ice-polished pavement at the latter place, and also from the fact that the glacier path is truncated by the present sea margins. Subaerial waste that was energetic through long ages, the repeated incursions of the sea during Tertiary times, as well as the periods of plateau formation, rifted segments, and block faulting, in later times, are sufficient to account for the wiping out of the glacial evidences and their non-appearance in the more northern situations of South Australia.

(?) Pre-Pliocene Beds in Section B.

Between the boulder-clay and the fossiliferous Pliocene beds at the head of the amphitheatre, at Hallett's Cove, are whitish and yellowish sands, sometimes argillaceous, which are of doubtful age. They are of uniform composition and free from stones. They come in, suddenly, at the northern side of the amphitheatre, immediately underlying the Pliocene bed, which, latter, thins out to the southward and its place is taken by the underlying sand bed which becomes a conspicuous feature in the white, conical hill known as the "Sugar-loaf." In the latter, it rests with a sharp division on the highly-coloured, reddish-purple boulder clay. The two colours, in juxtaposition, make a very striking contrast. The hill is capped by an outlying fragment of the Pleistocene mottled clays. The white bed continues to show in the cliffs to the southward and is also exposed in the uneven ground in front of the cliffs.

In the deepest gutter cut by the rains within the limits of the Cove (a little to the northward of the "Sugar-loaf") a section of the white bed is exposed up to a thickness of about 60 feet. This bed in its upper portion is soft and friable, but becomes more indurated at depth. In the thick section, just mentioned, it maintains a very uniform character, but towards the lower levels there are thin streaks of the dark-red clay and, at the lowest level exposed, it is seen to rest on the reddish-purple boulder clay that forms the base of the "Sugar-loaf." The induration of the bed in its lower portion is not uniform, but shows certain layers in relief, and, in common with the underlying boulder clay, dips to the north-north-east at a low angle.

The origin of this very considerable bed, sandwiched betweeen the glacial till and the Lower Pliocene, is not very clear. The question is complicated by the occurrence of a white sand bed that occupies a similar stratigraphical relationship to the Lower Pliocene in other localities, further to the south, that are in closer proximity to the freshwater beds that underlie the Miocene. So far as the Hallett's Cove section is concerned the weight of the evidence seems to point to its having some relation to the glacial conditions. It may have been deposited during a late fluvio-glacial stage in the building up of the sediments; or, even later, by running water, acting on the glacial deposits by gentle currents,

the clay being carried forward in suspension and the sand deposited. This bed is not seen in the glacial beds that face the sea at Hallett's Cove, which are at a higher level than the base of the white sand bed, so that it is possible that the latter occupies an eroded gutter in the boulder beds.

The assumption that the white sand bed at Hallett's Cove is stratigraphically related to the glacial beds gathers strength from the fact that at Queenscliffe, Kangaroo Island, a white sand bed rests upon the glacial clays, and, at the same place, the fossiliferous Miocene appears to occupy an eroded trench in this bed. Five miles to the west of Queenscliffe a similar white sand bed outcrops at the Gap Hills, where it rests upon the glacial clays and is overlain by a basaltic sheet (Howchin, W., 1899 and 1903).

Lower Pliocene Beds in Section B.

Next above the white sand bed, in the order of succession at Hallett's Cove, are the Lower Pliocene fossiliferous and calcareous sandstones. They have their greatest local thickness (12 feet) at their northern extremity (described under Section A) where they rest on glacial clay, which is held up by the Cambrian slates that form the cliffs at Black Point. They gradually decrease in thickness and thin out to nothing at the head of the Cove, where they give place to a thick, feebly-cemented bed of white sand which is destitute of organic remains and occupies an inferior position to the fossiliferous beds, as described above. Within the limits of the Cove the base of the Lower Pliocene is conglomeratic by the inclusion of water-worn erratics gathered from the underlying till.

Another outcrop of the fossiliferous Lower Pliocene sandstones occurs on the rising ground, about three-quarters of a mile to the eastward of Hallett's Cove, in Secs. 564, 565, Hundred of Noarlunga. The beds occur on the western side of the north and south district road, in scrub country. The beds form a retreating scarp, about 12 feet in height and half a mile in length, ending at their southern extremity close to the road that has formed the main road to the Cove. The rock is a siliceous sandstone, and, in places, a calcareo-siliceous sandstone, often gritty, and includes angular to rounded fragments of quartz, purple slates, etc., sporadically distributed through the sediments. The greater part of the rock seems almost destitute of organic remains, but, in places, a limited variety of fossil impressions on the rock are massed in considerable numbers. The commonest form appears to be *Tellina lata*, which, although not previously recognized at Hallett's Cove, has been recorded from the Upper Series at Aldinga. An external impression of a suborbicular bivalve with rather strong concentric lines may possibly represent a *Lucina*. The beds on their northern side are seen to rest on the purple slates and are covered throughout by a considerable mantle of travertine, which is exhumed and used for the building of dry walls, etc., in the neighbourhood as well as burnt for lime. The situation of the beds is fully 100 feet above the outcrop of beds of similar age at the adjacent Cove, and 200 feet above sea level. With the exception of the Mount Mary occurrence (Howchin, W., 1916, p. 258) this is, so far as known, the greatest altitude of the Lower Pliocene sediments in South Australia.

Resting on the Lower Pliocene fossiliferous beds is a white, somewhat compact, limestone, which is a very general feature of the Lower Pliocene beds throughout the district. It is unfossiliferous—except, at times, near the plane of junction with the underlying fossiliferous bed—and is, probably, of secondary origin, the lime, in the first instance, having been extracted from the underlying bed, by solution, and then redeposited at the surface as a travertine mantle. This supposed ancient travertine is sometimes separated from a more recent deposit of travertine by clays, while, in other places, it passes up into a more

concretionary limestone and marl that are being formed under present-day conditions.

The occurrence of fossils in the Lower Pliocene of Hallett's Cove is somewhat irregular. They occur mostly in patches. For some distance the rock may be comparatively barren, and then, for a space, they may be abundant. In the compact sandstone on the north side of the Cove the fossil remains are mostly in the form of impressions or casts. The most favourable position for obtaining them is near the head of the Cove and in calcareous nodules which occasionally occur in the sandy matrix.

The following fossil forms have been recorded from the Lower Pliocene (Kalimnan), at Hallett's Cove, including some additions from the writer's observations: —

PLANTAE.
Lithothamnion sp.
RHIZOPODA.
Orbitolites complanata, Lam.
ACTINOZOA.
Montlivaltia variformis, Dennant
Plesiastraea st. vincenti, T. Woods
ECHINOZOA.
Laganum platymodes, Tate
PELECYPODA.
Ostrea arenicola, Tate
O. sturtiana, Tate
Placunanomia ione, Gray
Spondylus arenicola, Tate
Pecten asperrimus, Lam.
P. antiaustralis, Tate
P. consobrinus, Tate
Glycimeris subradians, Tate
G. convexus, Tate
Mytilus submenkeanus, Tate
Lithodomus brevis, Tate
Anapa variabilis, Tate
Tellina lata, Q. and G.
GASTEROPODA.
Marginella hordeacea, Tate
Cominella clelandi, Tate
C. subfilicea, Tate
Campanile triseriale, Basedow
Diastoma provisi, Tate
Hipponyx australis, Lam.
Calyptraea crassa, Tate
Natica balteatella, Tate
M. subvarians, Tate
Heligmope dennanti, Tate
Potamides sp.

There are outcrops of the Lower Pliocene on the northern side of Rocky Point, and therefore included in Section B; but as they stand related to beds of the same age that occur on the southern side of the Point, in Section C, they will be considered in connection with the latter.

PLEISTOCENE AND RECENT ROCKS IN SECTION B.

The great difference in the weather-resisting qualities of the Palaeozoic rocks (which usually form the base of the sea-cliffs), as compared with the softer beds in the upper portions, leads to the formation, in many places, of a lower and an upper cliff, a platform of varying width dividing the two. The lower cliff wastes mostly by sea erosion, whilst the upper cliff, consisting generally of sands and clay, is worn away by atmospheric agencies, and as its retreat is more rapid than that of the lower beds a shelf or platform is formed, as stated above. This shelf is sometimes limited to a few feet, or it may be so wide that the upper cliff cannot be seen from the beach. When the erosion has been rapid the precipitous face is lost and the newer beds slope gradually upward to the higher levels. At the head of the amphitheatre at Hallett's Cove, in the absence of the Cambrian rocks, the shelf is formed by the top of the marine Pliocene beds which has become hardened by the deposition of a travertine limestone.

The beds that follow in superior order to the marine Pliocene sandstones can be divided into three divisions, representing differences of lithological character, with occasional planes of erosion dividing the same, which probably

indicate differences in geological age. These distinctions, as stated under Section A, are:—Pleistocene, mottled sands and clays; Recent, red clays and small gravel, passing up to a capping of concretionary limestone and marls, which latter are present-day deposits.

These newer beds are particularly well exposed in the amphitheatre of Hallett's Cove, carved into successive spurs by the rain causing little rivulets to wash out channels down the face. The mottled sands and clays (Pleistocene), which are slightly more indurated than the overlying red clays, show steeper faces than the latter and are sometimes cavernous. The section is a very striking example of the eroding effects of rain on soft rocks. The entire Cove, as an excavated area, has been formed by this simple agency. The surface at the top of the amphitheatre is higher than the ground at the back, which has a gentle slope to the east, so that no water finds its way into this amphitheatre except by the direct fall of rain within the area. The waste on the face of the cliffs, by this rain wash, is so rapid that no vegetation can establish a footing on these bare slopes. The retreat of the cliffs within the last 35 years is most marked (Howchin, W., 1918a, p. 69, figs. 51, 52), and as the ground at the back slopes away from the edge of the cliffs, the height of the cliffs will gradually diminish.

Section of Beds within the Amphitheatre at Hallett's Cove.

	Feet.
Recent:—	
Light sandy soil	2
Concretionary travertine and marl (6 feet to 15 feet)	9
Red and greenish clays, sometimes gravelly	20
Pleistocene:—	
Mottled red and grey argillaceous sands and clays	40
Lower Pliocene (Kalimnan):—	
Calcareous sands and grits (fossiliferous), stony at base, including derived erratics from the underlying till	3
Age Doubtful:—	
White sand, underlying the fossiliferous Pliocene but is quite distinct from it. Does not carry stones and is very fine and regular in the grain. Unfossiliferous. Is not present on the Black Point shelf; is slightly exposed on the northern side of the Cove and thickens in the exposures in washouts on the southern side	15–60
Permo-Carboniferous:—	
Glacial clays, sands, and grits, ranging from low-water level to 80 feet and 100 feet above sea level. Near the head of the Cove the till forms a finely laminated clay of a deep-red colour, which on the surface weathers into flakes of about an inch in diameter; in other positions the till takes the form of a greyish clay. It carries erratics of all sizes up to 8 feet in diameter. Near the coast the till is a sandy and gritty bed with glaciated boulders resembling the indurated sandy till of the Mount Compass district	90
Cambrian:—	
Purple slates and quartzites form the northern and southern limits of the over-deepened glacial valley.	

The sea-cliffs to the southward of Hallett's Cove exhibit very markedly the features of a double cliff. The Cambrian purple slates that form the lower

cliff show at their upper limits a peneplained surface, representing an ancient land surface. Recent erosion has removed the later deposits so as to form a shelf varying in width up to 200 yards. On this shelf the Pleistocene beds form a very distinct secondary and retreating cliff, which attains a maximum height of about 40 feet, and is pretty constant for about a mile, measured from the Field River. The beds are chiefly of the sandy, mottled type, and in places, by induration, form sandstones. The latter are perfectly horizontal and finely laminated. One section showed a sandstone, about 18 inches in thickness, resting on the Cambrian beds, and was overlain by mottled sandy clays, with a vertical scarp of sandstone on top, about 12 feet in thickness.

In a small washout, that cuts these alluvial beds transversely (the material from which is carried across and over the edge of the Cambrian platform), there is a remarkable assemblage of large, rounded stones, up to over a foot in diameter, and covering a space 20 yards wide, the origin of which is not very evident. As they occur at about 90 feet above sea level they can scarcely be regarded as an elevated beach deposit. The most plausible conclusion is that they are the coarser residues of the washed alluvium—stones that proved too weighty for the small rain-wash to carry over the edge of the cliff. Some loose stones, washed out of the local sandstone, occur away from the direct line of the wash, and it is likely that the rounded stones formed part of one of the ancient lines of drainage, as in the case of an old river bed exposed in a railway cutting a little to the northward of Hallett's Cove railway station.

At the end of the mile referred to, the upper cliff disappears, and gives place to a gentle slope of arable land with a low scarp of travertine limestone at the back.

On the shelf, formed by the greater hardness of the rocks that form the lower cliff, as well as on the top of the upper cliff, patches of sand sometimes occur which, in places, are of considerable thickness. It is a very common feature along the cliffs up to Sellick's Hill, but its origin is not always easy of explanation. The probability is that these sand cappings have had more than one mode of origin. In certain low situations the sand has been carried inland from the beach, by the wind, but in some instances the sand patches occur under circumstances in which such an explanation seems unlikely, as, for example, where they occur on a high precipitous cliff with a rocky shore below that is practically destitute of sand. There is little doubt that some of the sand patches represent residuals of the Lower Pliocene beds, as well as the Pleistocene sandstone, which once extended over all this area, and are still seen in bedded form, occasionally, while the greater portions of the associated material have been removed by denudation. This explanation receives confirmation by the presence of characteristic water-worn pebbles associated with the sands, in places. These dry, sandy areas were favourite spots of the aborigines in selecting camping grounds, and yield many evidences of their presence in past times.

A patch of sand, several acres in extent, occurs on the top and back of the cliffs a little to the southward of the Field River. It does not seem probable that the sand was blown up from the present beach, which is rocky and almost destitute of sand, and there is a nearly vertical height of about 100 feet separating the beach from the sand on the top of the cliffs. The present movement of the sand is in the direction of the sea coast and is blown over the edge of the cliffs. A patch of this sand, about two acres in extent, to the southward of Field River, recently placed under cultivation, has become entirely bared by the wind, exposing an old aboriginal camping ground including many undisturbed hearths, while the surrounding ground is covered with stone chippings. The floor is also extensively strewn with nodules of white travertine that look as though the ground was covered by large hailstones. Some patches of sand are probably connected with the extensive areas of blown sand that exist inland, pertaining to the ancient

river system, as, for example, at Blackwood, Happy Valley, Morphett Vale, etc. In this fluviatile valley, Blackwood would represent the eastern side of the ancient river valley, Morphett Vale about the centre, and the coastline the western banks of what is now a "dead" river.

On the landward side of Curlew Point there occurs one of the most extensive washouts to be found along the coast. A wide gully has been excavated by the rain, bounded by bare and vertical walls, 150 feet in height, and extends inland for about a quarter of a mile, and then, at its head, bifurcates in north and south branches (Howchin, W., 1918a, p. 70, fig. 54). It forms a remarkable exposure of the Pleistocene, or later, fluviatile beds. Its recent origin is indicated by the slight impression that the outflowing water has made on the nearly vertical sea-cliff, giving the features of a "hanging" valley.

The following is a Geological Section of the beds as exposed a little north of Rocky Point:—

Geological Age.	Estimated Thickness.
RECENT—Nodular travertine	15 feet
Sands and clays	20 feet
PLEISTOCENE—Mottled sandy clays with layers of hard white sandstone and water-worn pebbles, the harder beds showing vertical jointing	30 feet
LOWER PLIOCENE—Hard, gritty, siliceous, and calcareous sandstone, containing casts and impressions of fossils, coated on top with a nodular travertine	5 feet
CAMBRIAN—Rotten, purple-coloured slates	50 feet
(Underlain by very siliceous quartzites that outcrop on the beach)	

SUB-SECTION C.

ROCKY POINT TO THE MOUTH OF THE ONKAPARINGA RIVER (3 MILES).

CAMBRIAN ROCKS IN SECTION C.

The Cambrian rocks make only a small exposure in the cliffs from Rocky Point to the outlet of the Onkaparinga River. The south-westerly strike of the beds having taken the strong outcrops of quartzite to seaward, the soft purple slates, overlying the latter, offer only a feeble resistance to the action of sea and rain, and, in consequence, the Cambrian beds disappear from the cliff sections within a short distance to the southward of Rocky Point, their place being taken by newer beds.

From Rocky Point to the outlet of Morphett Vale Creek (a distance of about three-quarters of a mile) a remarkable combination of geological features present themselves (see fig. 1). The cliffs being composed of comparatively

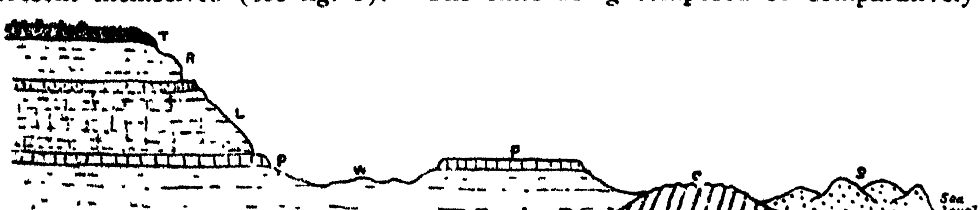

Fig. 1.

Section of Cliffs on the Northern side of Morphett Vale Creek.

S, Sand dunes. T, Travertine. R, Recent Clays. L, Pleistocene Clays and Sandstones. (See pl. xxiii., fig. 2, which gives a section of these beds with hard bed on top.) P, Lower Pliocene Fossiliferous Bed. W, White Sand, partly argillaceous. C, Cambrian Rotten Slates.

soft rocks have retreated and are set far back from the beach, leaving a shelf of broken and humpy ground, about a quarter of a mile in width, in which several stratigraphical unconformities are visible.

At about half-way between Rocky Point and the Morphett Vale Creek, and midway between the beach and the high cliffs, there is an inlier of Cambrian slates, bluish in colour, and so soft as to be easily mashed by the fingers, like clay. These rotten slates are interbedded with occasional bands (up to 18 inches in thickness) of a ferrugino-arenaceous character, making striking effects in a contrast of colours. The dip of the beds is to the east at an average angle of 65°. There are no further exposures of Cambrian beds on the coast until a short distance before reaching Blanche Point.

(?) Pre-Pliocene Beds in Section C.

Underlying the fossiliferous Pliocene beds, and resting unconformably on the eroded edges of the Cambrian slates (as shown in text fig. 1) is a freshwater series of sands, argillaceous sands, gritty sands, and, occasionally, of fine gravel, mostly of a whitish colour. The sand is unconsolidated, perfectly soft and free to the feel and very uniform; it carries no fossils, and whilst weathering into what looks like laminar bedding, cannot be separated on the laminae, as it has no cohesion, but is subdivided by layers of ironstone or ferruginously cemented sand; the bed exhibits false bedding in places, and has a slight northwesterly dip. The plane of junction between this sand bed and the underlying Cambrian slates is a ferruginous lateritic layer an inch or two in thickness. This sand bed is seen to pass under the fossiliferous Pliocene bed on the northern side, and increases to a thickness of about 30 feet on its southern. Following which, the Pliocene sandstones have been removed by denudation, and the underlying soft sand bed has also been reduced by exposure and partly obscured by more recent deposits. A similar bed of white sand underlies the fossiliferous Pliocene at Hallett's Cove (see p. 288), but whether the bed, now under description, has a closer stratigraphical relationship to the overlying Pliocene, or to the basal beds of the Miocene (seen further to the south), or corresponds to the white sandstone that intervenes between the fossiliferous Pliocene and the glacial till at Hallett's Cove, it is difficult to say.

Lower Pliocene (Fossiliferous) Beds in Section C.

Between the sea-stack (on the beach) and Rocky Point two indentations have been made in the cliffs by rain erosion (see p. 286) by which excellent sections of the beds can be seen. The fossiliferous Pliocene that disappears at Hallett's Cove, from denudation, reappears in the two small coves just mentioned. When viewed from the beach the fossiliferous bed is easily distinguished from the other geological formations and forms the sky-line; but on reaching its level it is found that there is still another cliff behind it. The hard sandstone of the fossiliferous bed has protected the softer Cambrian beds beneath from denudation, while itself, more resisting than the overlying beds, forms a shelf, from the edge of which the softer beds of clay have retreated, and the latter, again, form a double line of supplementary cliffs at the back, the first consisting of the mottled clays, and the second by the more recent clays, finished off by a travertine capping.

The Pliocene bed is about 5 feet in thickness, and, as a rule, calcareo-siliceous. It is sparingly fossiliferous, locally, except on some planes in the bedding, when the whole surface of the rock may be covered by internal casts of mollusca, mostly of small bivalves, sometimes masked by a mineral coating. At one outcrop were collected such typical forms as *Spondylus arenicola*, Tate; *Lagaaum*

platymodes, Tate; and a specimen of *Plesiastraea,* which seems to differ from each of the two species of this genus described by Tennison Woods.

The cliffs opposite to the Rocky Point stack consist mostly of alluvium which has been washed down on to the face of the soft and yielding Cambrian slates, and has, at the same time, obscured the outcrops of the fossiliferous Pliocene beds. They are no doubt continuous over this area, as some indications of their presence can be detected in a place or two, but they make no very distinct feature in the cliffs until they are seen on the broad platform of the lower cliff, immediately to the south of Rocky Point, as described below.

Near the northern end of this platform there is a conspicuous exposure of the fossiliferous Pliocene, forming a scarp about 15 feet in height, and is continued in a length of about 250 yards. The rock has been a calcareous sandstone, but is now mostly leached of the calcium content Fossils occur in the rock sparingly, and chiefly as impressions on the bedding planes. Towards the southern end of this platform the Pliocene sandstone is entirely altered to a highly ferruginous and cavernous rock. This change in the lithological character of the rock is maintained to the end of the platform area, and even beyond the isolated fragment, or butte (pl. xxiii., fig. 2), which marks the termination of the high cliffs to the southward. Ferruginous cappings occur still further to the southward, together with some red rocks, which may be inliers of the Freshwater Series that underlie the fossiliferous Miocene beds that occur to the northward of Witton Bluff.

Near the butte, just mentioned, are two washouts in the form of canyons, 20 feet deep, that run back from the beach almost to the base of the butte. On the southern side of these canyons is an isolated hill capped by the fossiliferous Pliocene. It forms an outlier from the main body of the rocks of this age, but has not been ferruginated, as in the case of the adjacent Pliocene sandstones. The bed contains fossil impressions and an example of the characteristic foraminifer, *Orbitolites complanata,* three-quarters of an inch in diameter, was obtained at this spot. The fossiliferous bed is underlain by the white sandstone found in the same position at other spots within the platform area.

The outcrop of the Lower (fossiliferous) Pliocene within the limits of Section C extends for a distance of about one and a half miles.

Miocene Beds in Section C, including the Underlying Freshwater Beds.

From the outlet of Morphett Vale Creek to near Witton Bluff the sea-cliffs are composed exclusively of alluvial deposits which will be described later. Along most of the beach between these two points large rounded stones derived from the Miocene beds are packed up by wave action against the foot of the clay cliffs, more particularly on the side towards the Bluff. It is not unlikely that these well-worn stones may have been derived from a reef of this rock that causes breakers about half a mile from the shore, although it is possible that, as beach stones, they may have travelled northward from the Bluff.

Witton (or, more correctly, Whiten) Bluff, situated on the northern side of Port Noarlunga, is a prominent headland with a deep recess cut by the sea on its northern side. The greater part of the headland is composed of beds of Miocene age[1] which are highly fossiliferous and show a distinct dip to the south-west. In consequence of this tilt of the strata the base of the series is exposed on the northern side of the headland, and the upper portions pass below

[1] The late Professor Ralph Tate and some other Australian geologists classified these beds as Eocene, while Professor J. W. Gregory, F. Chapman, R. B. Newton, and others with European experience, regard them as of Miocene (Janjukian) age. See Report Brit. Assoc. Adv. Science, 1914, pp. 371-376.

the surface before reaching the jetty on the southern side of the point. Most of the clay deposits of newer date have been removed by denudation from the surface of the fossiliferous rock; the latter faces the sea in scarps and terraces, the white colour of the stone having suggested the name of the headland.

The main bed in the fossiliferous series consists of whitish Turritella clays *(T. aldingae)*, probably representing the same horizon as the darker-coloured clays, rich in *Turritella,* seen at Blanche Point, a few miles further to the south. While the gasteropod mentioned is extraordinarily abundant at Witton Bluff there is a scarcity of other fossil remains. Next to *Turritella* the most common occurrence is a large form of polyzoa, which, although possessing only a very thin zooecium, spreads out into large convoluted fans that make masses up to 18 inches in diameter. In no case is it well preserved, often only a ferruginous line marks the outline of the form. It has the habit of growth possessed by *Retepora,* and probably belongs to that genus, but I have been unable to examine the celluliferous surface. Another common, but equally badly preserved, fossil occurs in large bunches of cylindrical and dichotomous stems, but failed under examination to give structure. It is often converted into a ferruginous cast and is probably a coral. The habit of growth of this organism suggests either *Amphihelia striata,* Ten. Woods, or *Cladocora contortilis,* Ten. Woods. Other fossils obtained included *Dentalium (Entalis) subfissura,* Tate; a considerable variety of spines belonging to the Echinozoa; and fragments of the stems of the interesting and rare crinoid, *Pentacrinus stellatus,* Hutton; *Ditrupa wormbetiensus,* McCoy; and one of the calcareous plates of a Cirriped that retains the original colour bands. A washing of the white clay yielded a very large number of monactinellid sponge spicules.

Resting on the Turritella clays (which are about 20 feet in thickness) is another whitish clay, more friable than the underlying bed and more sparingly fossiliferous; in it the Turritellae are rare. The upper white clay is about equal in thickness to the lower and more fossiliferous bed, and the whole section of the marine series, on the southern side of Witton Bluff, may be estimated at about 40 feet in thickness.

In passing to the northern side of the Bluff, the beds outcropping more to the southward disappear, having been denuded as the result of a rise in the angle of dip, and lower beds of glauconitic sandstone make their appearance. These are highly fossiliferous and include a greater variety of forms than the beds higher in the series, consisting chiefly of mollusca, but the shells are matted together and somewhat difficult to obtain entire.

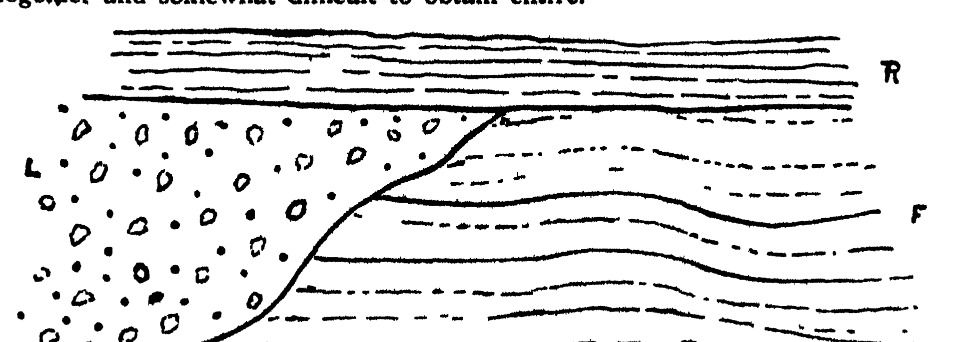

Fig. 2.

Two Stratigraphical Unconformities seen on the North side of Witton Bluff.

R, Recent Clays. L, Pleistocene Mottled Clays with subangular stones irregularly distributed through the Clay. F, Freshwater Beds that underlie the Fossiliferous Miocene.

Immediately north of the Bluff the last-described bed is seen to rest on the Freshwater Series—the lowest member of the Miocene System—which rises from beneath the fossiliferous beds and, within a short distance, becomes the sole feature of the cliffs. In this outcrop these fluviatile beds, in their upper portions, consist of brownish, fine-grained sands, and in their lower, of a white laminated clay with bands of brilliant brick-red colour following the bedding planes, the whole making a cliff of about 35 feet in height, but the base of the beds is not seen. They extend northward for about a quarter of a mile, in gentle flexures, and disappear in that direction under the Pleistocene clays, which latter occupy an uneven line of erosion excavated on the upper surface of the older freshwater series. At this point of junction a double unconformity is visible—the Pleistocene (mottled) clays, in a steep plane of erosion, cut out the Older Tertiary; while the Pleistocene clays, again, are eroded in an irregular line by the newer (Recent) reddish clays and gravels that rest upon them (see text fig. 2).

The junction of the marine and freshwater beds, in this section, is marked by very peculiar features; there has, apparently, been an interaction between the two dissimilar beds; either the iron in the brownish freshwater sands penetrated and discoloured the lowest layers of the marine deposits, or the glauconite contained in the latter has become oxidised by means of infiltrating water and thus produced a peculiar piebald discolouration. The rock is brown and white in irregular and sharply-defined patches, the one colour interpenetrating the other in such a manner as sometimes to simulate organic remains.

The sea is making rapid encroachments along this line of coast. The soft nature of the cliffs and the narrow foreshore favour the action of the waves. A conspicuous sea-stack, known as the Whiten Rock (or Table Rock), situated about 50 yards from the headland, and which had, apparently, remained unaltered during the period of European occupation of the country, was, in 1911, washed away, by which one of the most picturesque features of the coast was destroyed.

Pleistocene and Recent Beds in Section C.

In such places along the coast, where the Cambrian beds are strong and act as barriers to the encroachment of the sea, the softer overlying rocks usually retreat from the edge of the cliff and form a second cliff with moderate slopes and rounded outlines. This is the case between Curlew Point and Rocky Point. Immediately to the southward of the last-named Point the clays, of two ages, form the main cliffs and are set well back from the beach, reaching a height of about 150 feet. The older of the two, consisting of mottled (Pleistocene) clays and sandstones, rests unconformably on each, in turn, of the three older formations—the Cambrian slates, the freshwater sands, and the marine Pliocene—that occupy the area between the beach and the main cliffs. They exhibit features that are identical with the other outcrops of these beds along the coast and also inland. They vary from a very stiff clay to laminated sandstones, and, in places, contain lenticles of gravel made up principally of pebbles derived by erosion from the local exposures of purple slates and sandstones. The beds of sandstone (which are usually of a deep-red colour, or mottled red and grey), by virtue of their superior hardness often make prominent outcrops with vertical faces.

Resting on the variegated clays and sandstones is a greenish-coloured clay that is less resisting to the weather and has a slope lower than the mottled clays. This upper clay bed is capped by nodular travertine, white marly subsoil, and surface soil; the limestone is probably a precipitate from surface waters that drain over the Brighton limestone series that outcrop at a short distance from the coast on the landward slopes.

There could scarcely be a more striking illustration of rain erosion than is seen in these lofty and bare cliffs, set far back from the sea, the waves of which have never washed their base, yet they are wasting so rapidly that no living plant can establish a footing on their slopes. They do not weather in a straight line, but the rain sculptures the face of the cliffs into regular scallops, nicked by crevices and varied with coves and buttes. At the southern end the cliffs are suddenly truncated facing to the outlet of Morphett Vale Creek, where a picturesque butte (see pl. xxiii., fig. 2) has been isolated and is surrounded by many acres of perfectly bare clay, undergoing waste, which, on a small scale, recalls to mind the "bad lands" of the Colorado.

The outlet of the Morphett Vale Creek is largely choked by sandhills which form the banks on either side. On the southern side of the creek, and for some distance in the same direction, there are usually thick layers of a black and ruby-coloured sand piled up against the base of the cliffs, giving the sands an appearance of being covered with coal dust.

A little south of the Morphett Vale Creek the upper clay beds of Recent age begin to show themselves at about high-water mark and form a cliff about 10 feet in height. As these beds are washed by high tides the cliff is rapidly retreating. These clays continue to form the only feature of the sea-cliff for about a mile in length, the latter slowly increasing in height as it goes southward. At about half-distance between the Morphett Vale Creek and Witton Bluff the underlying mottled clays and sands begin to show themselves in the cliff section. The contrast between the two beds of clay is here very marked. The lower bed is a compact, greenish and reddish mottled sandy clay, carrying numerous angular, or more or less rounded, stones sporadically distributed through the mass and lying at all angles. The bed is sufficiently tenacious to resist for some time the action of the waves, as large patches, a foot or two in height, occupy the beach between tides. Harder portions that have become strengthened by calcareous or siliceous infiltrations stand up as ridges intersecting the beach after the softer portions have been washed away. The bed, in its upper limits, becomes grey and red, in mottled patches, but preserves its essential features in its compactness and the sporadic manner in which the included stones are distributed. In both cases the stones consist mainly of quartz and quartzite, and in addition to these there are irregular concretions such as are commonly found in fluviatile sediments. A precisely similar clay bed makes a low cliff a little south of the mouth of the Aldinga Creek.

The relationship which the newer and less compact clays bear to the older mottled clays can be well studied on this part of the coast. A very distinct unconformity can sometimes be recognized between the respective beds—the overlying reddish clays and water-sorted gravels occupy gutters of erosion in the underlying compact clay.

With the exception of a large conical sandhill, situated a little south of the Morphett Vale Creek, no important sandhills exist at prseent between that creek and Witton Bluff, the wind having swept the low cliffs entriely bare of their sand, and the exposed floor consists of a continuous sheet of nodular travertine.

From the jetty at Port Noarlunga to the mouth of the Onkaparinga—about a mile of coast—there are uniform features. The whole distance is covered by sand dunes which rise to a height of 50 feet or 60 feet. As soon as the tidal flats are reached, at the mouth of the river, the older marine Tertiary beds appear in the form of low tabular exposures situated between tide marks.

SUB-SECTION D.

FROM THE MOUTH OF THE ONKAPARINGA RIVER TO THE RED OCHRE COVE (4 MILES).

MIOCENE BEDS OF SECTION D (INCLUDING A SMALL OUTLIER OF FOSSILIFEROUS PLIOCENE).

The estuary of the Onkaparinga has been excavated to base level in the marine beds of the Miocene. The latter can be seen at, or below, sea level in the broad entrance to the river and in cliffs on either side of the wide estuarine flats; they are exposed in the railway cutting and are banked up against the Upper Cambrian purple slates on both sides of the Noarlunga township. On the north side of the township the beds have a decided dip to the south-west and exhibit shelvings below high-water mark. On the southern side, at the convex bend of the "horseshoe," they form the cliff, bounded by the purple slates on the one side and clay beds and gravels on the other.

Fossiliferous beds of the same age occur in two railway cuttings near Hackham, and also on the adjacent main road, about three miles to the north-east of Noarlunga, at an elevation of 200 feet above sea level. Further again to the northward highly glauconitic fossiliferous clays underlie Morphett Vale and are exposed in the cuttings at Happy Valley reservoir. At about one mile up the Onkaparinga River from Noarlunga, the junction of the Adelaide Series and the Cambrian purple slates can again be studied, where the Brighton limestone crosses the river in contact with the purple slates, and, about four miles further up the gorge, the stream intersects the Cambrian tillite.

Within half a mile of the sea the Onkaparinga narrows its bed with high sandhills on its northern side, and on its southern side the older marine beds (Miocene) make prominent and often vertical cliffs. The lowest exposed beds in the series outcrop at the landward end of the cliffs. At that end the beds consist of polyzoal rock, 2 feet to 3 feet in thickness, alternating with glauconitic clays which are sparingly fossiliferous. The upper members consist of grey-coloured argillaceous, varying to sandy, rocks, in which fossils are scarce, and these beds are capped by a hard calcareous sandstone, also poor in fossils.

At the southern head to the entrance of the river the marine beds are much weathered, by the waves on the one side and the rain on the other, into hard and bare terraces. Within the heads they have a thickness of about 30 feet and are capped by Recent reddish clays and gravels. The newer marine series (Pliocene) is not represented in this section and in positions higher up the estuary, where the lower marine beds come to the surface, they are capped by only a thin layer of travertine. The fossils mostly belong to the polyzoa. *Cellepora gambierensis*, Tennison Woods, is particularly abundant; there also occur examples of *Reticulipora, Lichenopora, Pecten hochstetteri*, Zittel, scattered spines of Echinozoa, etc.

On rounding the headland which forms the southern boundary to the entrance of the Onkaparinga, going southward, the lower marine beds form low cliffs and also platforms on the beach. Here they are richly fossiliferous in certain forms, especially the large and massive cup-shaped *Cellepora,* and many pectens, including *P. eyerei,* Tate; *P. flindersi,* Tate; *P. peroni,* Tate; and *P. hochstetteri,* Zittel.

The beds, both within the limits of the estuary and also along the beach to the southward, roll in gentle and extended curves having a general dip to the south-west, with an extreme inclination of about 4°. In consequence of this pitch they gradually pass down to sea level and for some distance are confined to the beach, between tide lines, and can be traced almost to the outlet of

Pedler's Creek, a distance of nearly two miles. Before this creek is reached, however, there is a small outlier of the newer marine beds on the beach, but above high-water level, which is fossiliferous, and yielded such typical forms as *Ostrea arenicola,* Tate; *Laganum platymodes,* Tate; and *Pecten antiaustralis,* Tate. This is the only known occurrence of rocks of this age between the Aldinga cliffs and the area previously described, situated on the northern side of Morphett Vale Creek.

On the southern side of the sandhills (that occupy the low ground at the mouth of Pedler's Creek) is another small but interesting outlier of the fossiliferous Miocene beds. It is probable that they have been preserved by a trough fault that has brought them into contact with the broken edges of the Cambrian strata. A small fragment of the underlying freshwater beds is exposed in a washout at the back of the section, and, resting on these, is a very white argillaceous limestone which bears a close likeness to the Witton Bluff beds, and, like the latter, is no doubt a bleached form of the less altered Aldinga Turritella clays. The fossiliferous beds are about 20 feet in thickness, having a dip of 24° to the north-west. They form the main cliff for about 100 yards in length, and pass out of sight on the northern side beneath the newer deposits. About 200 yards to the northward of this outcrop the same beds are seen, at low-water level, in several parallel ridges that rise about a foot above the level of the beach. Their slight elevation makes it difficult to estimate their angle of dip, but they appear to have a higher inclination than the beds in the cliff section and the dip is more westerly. One of these outcrops is an exact counterpart of the dark-coloured Turritella clays of Blanche Point. The beds on the beach are more fossiliferous than those in the cliffs and the fossils are better preserved. *Turritella aldingae,* Tate, is in great numbers (as casts in the cliff beds but with shells preserved in the outcrops on the beach); casts of *Voluta* sp., *Cypraea* sp., and *Dentalium* sp.; *Pecten hochstetteri,* Zittel; *Magellania* sp. (crushed fragment); large masses of *Cellepora gambierensis,* Ten. Woods; also the imperfectly preserved (?) *Retepora* and (?) *Cladocora contortilis,* Ten. Woods, occur, embedded in the clay, as in the Witton Bluff section. Many and various spines of Echini are scattered through the bed, but no echinoid test was seen *in situ,* although plates of *Cidaris* were found, and a fine example of *Holaster australiae,* Duncan, was picked up on the beach.

Cambrian Beds in Section D.

The Cambrian beds abut against the lower marine outlier, just described, on its southern side, and, for about a mile in length, once more make the principal feature in the sea-cliffs. The beds consist of purple and grey slates interbedded with very strong whitish and fine-grained quartzites. The beds roll in flexures up to a dip of 45° and are covered by a retreating cliff of the reddish clays, while the latter are capped by a considerable development of a white, earthy travertine, which is also set back from the face of the cliffs, so that, as a consequence of the variable degrees of weathering, the cliffs consist of three distinct faces and two ledges.

Near the southern limits of the line of cliffs, just described, there is a small cove that has been eroded on the axis of an anticlinal fold in the Cambrian slates. The beds are almost clay-like in their softness, and, as they are exceptionally highly coloured, the place has been a rendezvous for the aborigines in past times for obtaining red ochre for personal ornamentation and other decorations.

On the southern side of this little cove the Cambrian rocks make a low point and once more disappear from view and are overlain by the freshwater beds of the lowest member of the Tertiary succession, which, from this point,

form the most important feature in the sea-cliffs till Blanche Point is reached, a distance of a mile and a half. As these beds rise from beneath the older marine series at Blanche Point it will be more convenient to study them in connection with that part of the section and then trace their outcrops to the northward, which will be done in the next division of our subject.

Pleistocene and Recent Beds in Section D.

The main cliffs that occur between the estuary ot the Onkaparinga and Pedler's Creek are formed of reddish clays and gravel, much incised by rain sculpture. They reach their maximum height in the headland of Seaford (Sec. 340, Hundred of Willunga), at 100 feet, and have a bed of coarse and hard nodular travertine, 6 feet in thickness, near their upper limits; large blocks of this travertine encumber the beach.

Pedler's Creek is the most important outlet for surface drainage between the River Onkaparinga and the Myponga Creek, and at its mouth there is the greatest development of sand-dunes that occurs within the limits of Gulf St. Vincent. They have a frontage to the sea of about a mile in extent, and, on the southern side of the stream, they are a travelling mass, up to 100 feet in height, encroaching towards the north-east. This drift has evidently been long established, as the creek has been gradually driven, by their encroachment, further and still further to the northward. Its former outlet (into which the sea still flows in high tides) has been, quite recently, cut off from the main creek by the encroaching sand, and the flood waters have had to take a more circuitous course, while much cultivated land has become buried by the sand drifts.

An interesting feature of this part of the coast is the existence of a raised beach, evidences of which occur on both sides of the entrance to the creek. On the southern side a ridge of large rounded stones occurs enclosed within the present sandhills, distant from the beach by about 20 yards, and at a height of 12 feet above the present highest tides (see pl xxiii., fig. 1). These stones have been piled up by powerful wave action and in positions where no waves can reach them now. At the back of this raised bank of stones is a much larger area, more or less covered with rounded stones, and the usual littoral of a sea beach. This area has been recently bared by the wind and contains evidences of aborigines' occupation in numerous hearths, chipped stones, and broken *Turbo*, *Purpura*, and other shells, but the beach stones are far too numerous to be referred, in their entirety, to human agency, while many of the marine exuviae are of a kind that did not come within the range of the aborigines' attentions. A very large number of the shell, *Chama ruderalis*, Lam., occurs, many having both valves attached; also numerous small corals, polyzoa, brachiopods, and small mollusca, together with other beach sundries. In one place, on the northern side of the creek and near the landward limits of the raised beach area, a bed of *Coxiella badgerensis*, Johns, has formed a whitish calcareous deposit, which suggests the existence of a brackish pool or lagoon in which the waters of the sea and creek mingled, and in which this brackish-water gasteropod abounded.

SUB-SECTION E.

RED OCHRE COVE TO SNAPPER POINT (4¼ MILES).

Miocene Series in Section E.

Blanche Point, 140 feet in height, is the most striking headland within the limits of the coastline now under description. It consists of several subsidiary points, separated by small bays, together with a sea-stack ("gull-rock") that is usually surrounded by water. There is a close similarity between Witton Bluff (Port Noarlunga) and Blanche Point, both geologically and physiographically.

Each of these headlands owes its existence to the presence of weather-resisting calcareo-argillaceous marine beds. The latter belong, respectively, to the same geological horizons, the beds have about the same angle of inclination, and the occurrence of the softer fluviatile basal beds has led to a deep recession of the cliffs on the northern side of each of these headlands.

Basal Freshwater Beds.—The cliffs on the northern side of Blanche Point run due east and west for about half a mile, and then make a sharp turn due north (Maslin Bay). In this angle the basal (Tertiary) Freshwater Series is exposed and its junction with the overlying lower marine beds can be studied at sea level at about half tides. The beds rise, in a gradient of from 3° to 5° to the north-east. The marine beds gradually run out on this plane (truncated at the surface), and at about a third of a mile, to the north of the bend, the fossiliferous Tertiaries cease to appear in the cliffs and the mottled clays (Pleistocene) then rest directly on the basal fluviatile beds. The lowest fossiliferous horizon is glauconitic, and this bed rests on a greenish sand, which is not fossiliferous (except near its upper limits), and passes down to a brownish argillaceous sandstone which is, apparently, of freshwater origin.

The cliffs on the northern side of Blanche Point (Maslin Bay) are almost entirely composed of this Freshwater Series—brown and greenish laminated sands, generally very soft and friable, with thin leaf-like layers of ironstone at intervals. In places these beds show more consolidation and outcrops occur, between the tide levels on the beach, where they are sufficiently strong to resist the force of the waves. The beds show a thickness up to 60 feet in some cliff faces, but are subject to land slips; one such I noted, in 1911, that had shortly before slid many thousands of tons down to the beach.

In the neighbourhood of Bennett's Creek (the first creek north of Blanche Point, at a distance of about a mile, and situated in Sec. 368, Hundred of Willunga) the beds are capped by a bed of buff-coloured, compact, and very homogeneous travertine, large blocks of which have fallen to the beach. The surface of the limestone shows a peculiar weathering, in small parallel flutes, having a smooth, shiny surface. At a point, just north of Bennett's Creek, an outlier of the mottled clays is seen resting on the top of the travertine, just described, and on the top of the mottled clays is another travertine deposit, a few inches thick, and quite distinct in appearance from the one on the lower horizon. This would appear to imply a very considerable age to the latter.

About half a mile further north than Bennett's Creek is a small creek, or washout, that has cut a deep canyon in the Lower Tertiary Freshwater Series, with vertical walls, 30 feet in height. [This observation was made in 1911; in a later visit to this spot, in 1913, some of these vertical banks were found to have caved in.] The brown and greenish laminated sands here rest on a lower horizon of yellow, laminated sands, with thin layers of small subangular quartz pebbles possessing an average size of about half an inch in diameter. The sediments are false-bedded and irregular, with an average thickness of 3 feet. Then follow, in descending order, a drab-coloured plastic clay, 6 inches in thickness, and then a very coarse quartzose sand (much blackened in some layers), and layers of rather coarse gravel, the constituents being almost restricted to white quartz, a few examples of black quartz, and quartzites rare; all the stones are well water-worn and make a bed 3 feet in thickness. Limonite, in the form of thin leaves, layers, and nodules, occur in these beds as in the higher members of the series.

On the northern side of the canyon, just described, these lower freshwater beds are much obscured by sand, blown from the beach, as well as from the weathering and rain-wash from the overlying reddish-mottled sandstones, but the upper limits of the Freshwater Series is indicated by the distinctive travertine,

described above, which is here much decreased in thickness, partially leached, and its upper portions converted into limonite.

In another small washout the same clay bed (mentioned above as being 6 inches in thickness in the canyon washout) is seen to have thickened to 6 feet, and the underlying, white, quartzose sand bed is much coarser and the associated gravels larger in the grain, arising from the fact, no doubt, that the beds are almost down to bed rock.

The beds of the Cambrian Series come to the surface at a slight headland, immediately following the coarse sediments of the fluviatile series described in the last paragraph. The Cambrians are represented chiefly by a light-coloured, fine-grained, very siliceous quartzite, similar to outcrops noted further to the north, and have a dip south at 38°. The actual junction of the base of the Tertiary sediments with the bed rock cannot be seen, but there is a white, sandy, kaolin rock, with red streaks in it, exposed in a small washout, that may be the covering rock, and, in any case, it is very near the base.

Outliers of what are assumed to be the basal Tertiaries occur near the red-ochre cove, and also at the base of the marine Tertiaries, seen in the cliff section on the southern side of Pedler's Creek, as described above.

Fossiliferous Miocene Beds.—The marine Tertiary beds (lower and upper) in this line of outcrop extend from about a third of a mile northward of Blanche Point, and, southward, to a little south of Snapper Point, a distance, in a direct line, of about 3 miles. They have their greatest development in the sea-cliffs at Blanche Point. The rapid transitions in the nature of the deposits is well illustrated when the section on the northern side of the Point is compared with that on the southern side.

On the northern side of Blanche Point the lowest bed of the marine series is a pinkish-coloured limestone, about 5 feet in thickness, which is very fossiliferous, including many echini, brachiopods, polyzoa, etc. The next, following, is a greenish-white limestone, highly glauconitic, about 2 feet in thickness, and also very fossiliferous, the forms being similar to those present in the underlying bed, the upper portion being especially rich in *Turritella aldingae*, Tate. The two limestones, just described, appear to represent, in part, the very different dark-coloured earthy limestones largely developed on the southern side of the Point. The beds at a higher horizon are similar to those occupying a corresponding position on the southern side. In the return angle, to the north, the lower beds, rich in echinoderms, occupy the slopes of the cliff and, becoming more weathered as they approach the surface, supply an excellent collecting ground for fossils. The lower marine beds thin rapidly on the northern side and are reduced, within a few hundred yards, to half their thickness, the result probably of a floor of erosion along the plane of unconformability separating the two marine series. The glauconitic bed maintains its characteristic colour and can be easily followed by the eye along the face of the cliff. The overlying newer marine beds also thin out in the same direction, caused also by a plane of erosion of a later date, and within less than half a mile of the angle-bend both series have disappeared, the limestone passing rather abruptly from the cliff section, and the Pleistocene sands and clays rest directly on the fluviatile beds that have arisen from beneath the fossiliferous Tertiary rocks.

Blanche Point can be rounded, on foot, only at lowest tides. On the southern side (see pl. xxii., fig. 1) the lowest bed exposed is a dark-coloured argillaceous limestone (or calcareous clay) divided up into alternating harder and softer beds that are crowded with the gastropod shell, *Turritella aldingae*, Tate. These Turritella clays show a thickness of 31 feet, and with a slight dip, a little west of south, they form the littoral, 150 yards in width, and pass below sea level at low water. The latter are overlain by a yellowish, argillaceous, and

sandy bed, which passes, in places, into a rock consisting almost entirely of broken polyzoal remains. Fossils are fairly common in the bed, but have a limited range as to species; thickness of bed, 30 feet. The face of the cliff is almost vertical. In the lower part, the upper members of the Miocene Series are exposed, the harder layers standing out in relief, as shown in the photograph; and, near the top of the cliff, the Lower Pliocene limestone, underlain by a reddish sandstone that carries most of the fossils of these beds, can be seen (see also Tate, R., 1896, p. 123).

The headland of Blanche Point forms the northern limits of Aldinga Bay. From this point the cliffs make a slight landward curve and lose their precipitous character. Between the headland and Aldinga Creek (about a mile) the cliffs are in three stages. The lowest scarp is formed by Recent clays and blown sand, which make a hummocky slope lying against the Tertiary beds and, for the most part, obscuring the outcrops of the latter. The second scarp is formed by the white limestone of the Lower Pliocene beds, which, being resistent to weathering, makes not only a scarp face, but a well-defined platform or shelf. On this shelf—set back from the edge—the older and newer fluviatile beds form a third scarp.

The Aldinga Creek, which reaches the sea near the township of Port Willunga, breaches the cliffs and interrupts the continuity of the section. The cliffs that rise on the northern side of the creek exhibit some interesting features. A highly coloured bed of sandy clay, in red and yellow layers, forms a conspicuous feature in the cliff face, near the base. No fossils could be detected in this bed, which has the appearance of being a freshwater deposit. It is from 4 feet to 5 feet in thickness, and is seen to rest conformably on a dark-coloured clay that is sparingly fossiliferous near the plane of junction. One or two examples of *Limopsis insolita* and *Turritella aldingae* were observed here; but at a lower level, in the same bed, situated on the tidal slope, remains of *Turritella* are abundant.

Resting on the highly-coloured clay bed is a yellowish limestone consisting almost exclusively of small polyzoal remains. It is false-bedded and fissile, and is overlain by the Lower Pliocene sands and limestones. This section proves that the reddish (?) freshwater bed is included in the Miocene Series. The beds here have a dip of from 3° to 4° in a south-westward direction. This inclination causes the red-coloured bed to dip below the surface to the southward, but takes a rise to the northward.

At about a quarter of a mile to the northward of Aldinga Creek—on the northern side of the Memorial Life Buoy erected on the beach—the red clay bed makes a small waterfall in a washout, and is underlain and overlain by beds as they occur at Aldinga Creek (described above). No continuous section of the Miocene beds can be traced from this point, for nearly a mile, being much obscured by Recent clays. The red clay bed (interstratified with the fossiliferous Miocene), of supposed freshwater origin, is seen at intervals for some distance beyond the washout, mentioned above, but appears to thin out to the northward.

At Port Willunga jetty the older marine beds are represented by more or less consolidated sands that are exposed in a thickness of about 20 feet and are moderately fossiliferous. On account of the open texture of the rock the organic remains are limited to such forms as are the more stable in relation to the circulating waters that cause solution, such as *Pecten*, *Magellania* and other brachiopods, polyzoa, echinoderms, etc. It is difficult to say whether this lithological change in the sediments is due to local variation simply, or whether these sandy deposits occupy a stratigraphical position superior to those exposed at Blanche Point, but were removed from the latter by denudation before the laying down of the newer marine deposits which cover all alike. A break in the cliff section leaves this an open question.

On the landward side of Blanche Point the older marine beds form a strip of country, bordering the coast, for at least a mile and a half in width. A little east of Port Willunga, a north and south district road crosses the Aldinga Creek (Sec. 392, Hundred of Willunga), and in a cutting on the northern side of the stream these beds are exposed. The main road to Adelaide crosses the Aldinga Creek on the eastern side of the township, and after crossing the first ridge on the road and rising to the second, going northwards, the road passes through a deep cutting, at the southern end of which are marlstones containing remains of *Pecten, Turritella aldingae,* etc. (Secs. 377, 179, Hundred of Willunga). These fossiliferous beds are overlain by ancient fluviatile deposits. Still further to the north (but situated on the parallel road to the westward of the main road) are other outcrops of these beds. This district road, on the northern side of Bennett's Creek, goes through a deep cutting of the marine beds in which the characteristic *Turritella* occurs in great numbers. The fossiliferous rock is seen, not only on the road, but in outcrops in the adjoining grounds facing into Bennett's Creek (Sec. 374, Hundred of Willunga). The beds have an easterly trend and are no doubt connected with the outcrops on the main road described above. Similar outcrops can be traced at intervals as far as McLaren Vale, four and a half miles from the coast. A ridge of these rocks occurs on the northern side of McLaren Vale railway station—the district road that passes the station, going north, exposes a section of the beds in a cutting on the rise. The beds have also been proved in various sinkings in the neighbourhood, and are indicated, in places, by fossiliferous surface stones scattered over the cultivated land.

Between the township of Port Willunga and the jetty the older marine beds form the lower portion of the cliff in vertical walls of calcareo-siliceous rocks, but include layers of an argillaceous character. The gradual dip of the beds to the south-west, at a low angle, reduces the height of the cliffs to the southward, until each superior bed, in turn, reaches sea level.

From Port Willunga jetty, southwards, there is a wide floor of the Tertiary rocks, extending from the base of the cliffs, seawards, representing a plain of marine denudation that is bared at low water. At Snapper Point this marine pavement has a width of, at least, a quarter of a mile which is bared at low water and evidently causes shallow water much further out to sea. Snapper Point presents the unusual feature of a headland that has a greater extent of foreshore than the cliffs on either side. This no doubt arises from the great breadth of the rock pavement which breaks the force of the sea and has led to an accumulation of sand in front of the Point. The sea has receded at this point, within recent times, the cliffs being situated inland and are bordered by a festoon of sandhills, between the cliffs and high-water mark, with a well-grassed valley between the sandhills and the cliffs.

Lower Pliocene Beds in Section E.

The fossiliferous Pliocene beds are practically continuous from Blanche Point to Snapper Point. At Blanche Point the beds form the upper limits of the vertical face of the lower cliff. Southward from the Point they make a distinct scarp and platform in the cliffs, as far as Aldinga Creek, the white, craggy limestone of the beds rendering them conspicuous.

These newer marine beds are, in a general way, divisible into two parts which are very much in contrast from each other. The lower portions consist of white and reddish sands, either friable or irregularly cemented, and contain most of the fossils. The upper portions consist of a white marly limestone, often concretionary in structure, and weathers into a rough and craggy face which is, generally, the most prominent feature in the outcrops. Grains of

sand are often irregularly distributed through the limestone, and fossils, when they do occur, appear to be limited to its basal portions. At Port Willunga jetty, beds of this age occupy an intermediate position between the older marine below, and the Pleistocene clays that overlie them, and slope gradually with the dip to the level of the beach on the southern side of Snapper Point.

This gradual inclination of the Tertiary beds to the southward brings within reach, in succession, the upper beds and provides good hunting grounds for the fossils of the Upper Marine Series. Many of the forms which are common in the lower marine Tertiary, such as polyzoa, brachiopods, echinodermata, and corals, are almost absent from the newer (Pliocene) Marine Series, but *Ostrea arenicola,* Tate, is extremely common, many having the two valves attached; *Spondylus arenicola,* Tate; *Pecten antiaustralis,* Tate; *P. subbifrons,* Tate; and *Laganum platymodes,* Tate, are characteristic forms and somewhat common. Local silicification has cemented some portions of the matrix, while other parts remain free, and, from this fact, many fossils can be easily cleared of the matrix on one side while firmly held by the silicified rock at another. The thickness of the beds averages about 20 feet.

The white marly limestone, which forms the upper portions of these beds, comes down to sea level on the southern side of Snapper Point, and exhibits some interesting features. There is a sharp line of separation between the limestone and the fossiliferous beds beneath. The latter have been greatly leached of their lime content and, mostly, retain only external impressions and casts of their organic remains. The composition and structure of the overlying limestone are much in contrast from that of the fossiliferous bed, being often markedly nodular, and the rock contains rounded and angular stones that are foreign to the rock in which they occur. Among these included stones are examples of the fossiliferous rock on which the limestone rests. There are also in the limestone very curious rope-like forms that are sometimes knotted and twisted, and, when microscopically examined, appear to have a kind of cellular structure. They vary in size from small twigs to large root-like masses, 4 to 5 inches in diameter. These features are very suggestive of a travertine limestone, and, if so, supplies important evidences concerning the hiatus which exists between the marine conditions, indicated by the underlying bed, and the mottled clays (? Pleistocene) which follow next in the order of succession. When the sea-bed was raised to dry land (given suitable climatic conditions) a travertine would form on its exposed surfaces, as occurs in this country at the present day on all calcareous soils in dry situations, and would account for the leached condition of the fossiliferous marine bed, the lime having been extracted from such by circulating waters and precipitated as a capping on its upper limits. The inclusion of stones and fossils in the limestone near the plane of junction is what would naturally occur in such a process, and the ropy, stem-like forms, found in certain positions in the limestone, is paralleled by the sand-pipes and stem-casts which are constant features of the surface travertine and calcareous sands at the present time. The removal of the lime from the fossiliferous sands prepared the way for the entrance of silicated waters which, in many instances, have filled up the interstices with silica and produced siliceous pseudomorphs of the organic remains. A newer travertine, of Recent age, occurs in the same section near the top of the cliffs.

On the southern side of Snapper Point the Tertiary limestones make a slight show near the base of the cliffs and occupy most of the beach. They can be traced along the littoral for about a mile from the Point, when they are no longer visible, having dipped below the level of low-water mark. They are not seen again until the wide and open valley of the former Onkaparinga outlet is passed, when they reappear under new stratigraphical features.

Pleistocene and Recent Beds in Section E.

The Pleistocene and Recent beds in Section E maintain a close resemblance to those already described that occur to the northwards. The form in which the upper argillaceous beds retreat from the edge of the harder under-cliff is well seen when Blanche Point is viewed from a short distance, or, when standing on the midshelf formed by such retreat, as shown in pl. xxii., fig. 2.

The outlet to Aldinga Creek (at Port Willunga) possesses some features of geological interest. The creek has cut its way down to base level. Where it makes its exit to the beach there are remains of an ancient carbonaceous mud deposit that is sufficiently indurated to withstand the action of the waves for some time. It is best seen on the northern side, as the southern banks are obscured by drift sand. The present stream has worn its way down through the old fluviatile deposit to a depth of about 8 feet without exposing its base. The adjoining cliff, facing the sea, supplies a section of the bed to this extent and shows that the carbonaceous mud deposit occupies the position of a wedge that divides the older (mottled) clays from the newer reddish clays, and thins out to nothing between these two formations. The indurated mud contains many plant impressions, but these are too fragmentary and decayed for determination. In one place numerous shells of the gasteropod, *Coxiella badgerensis,* were seen grouped together on one of the layers. This carbonaceous bed gives evidence of the existence, at a former time, of a sluggish pool of fresh or brackish water that flowed at a higher level than it does to-day, and probably met the sea at a point further to the westward than it does at present.

SUB-SECTION F.

FROM A LITTLE SOUTH OF SNAPPER POINT TO SELLICK'S HILL BEACH ROAD (3¼ MILES).

There are few physical features that distinguish this portion of the coast. About a mile to the southward of Snapper Point the sea-cliffs disappear and are replaced by low sand dunes which mark the northern side of the alluvial valley, three miles in width, which represents the ancient river flats of the Onkaparinga before its diversion 12 miles to the northward. The country between Aldinga and Sellick's Hill, by road, is quite flat. On the Sellick's Hill side of the valley a number of weak springs make a seepage from the hill sides. This, together with a small amount of drainage derived from the local rainfall, finds its way to the coast, but being dammed back by the sand dunes, forms a small brackish lagoon (the "Salt Lake") which, in summer, usually evaporates, leaving a saline incrustation on the surface. This is all that is left of what was, in the near past, the outlet of one of the more important rivers of southern Australia.

Shortly after passing the lagoon, going southward, the clay cliffs begin to show again with a gradual increase in height. A serious washout has developed in these beds at the lower end of the district road that leads from Sellick's Hill to the beach. It is said to have been started by an adjacent landowner having turned the drainage from his field into the road. The washout in its lower reaches is divided into several branches which in the aggregate cover and has rendered impassable about two acres of ground (in 1911), some parts of the canyon reaching a depth of about 25 feet.

SUB-SECTION G.

FROM SELLICK'S HILL BEACH ROAD TO THE END OF THE FOSSILIFEROUS TERTIARY BEDS (3 MILES).

The clay cliffs, which at the beach road have a height of about 30 feet, gradually rise to the southward until they reach a maximum height of about

200 feet (pl. xxiv., figs. 1 and 2). The Sellick's Hill Creek, which takes its rise to the eastward of the township, does not reach the sea, but becomes absorbed in the gravel beds while on its way. The best section of the beds can be obtained from a deep and long washout, which has almost reached the dimensions of a creek, that opens to the beach near the end of the first exposure of the Miocene beds in the cliffs (Sec. 277, Hundred of Myponga). This small creek has cut a steep and deep valley in these beds, almost down to sea level, and goes back for about half a mile in the same alluvial deposits.

On going up this creek the bed is burdened with large blocks of stone which are 2, 3, or 4 feet in length, mostly of a buff colour, but sometimes pink, and sometimes almost black (carbonaceous). These stones of Cambrian age have been derived from the indurated shales (or slates with imperfect cleavage) which underlie the Cambrian limestones and are seen in outcrop at the lower part of the Sellick's Hill road, near the Sellick's Hill Creek. At the distance of about one-eighth of a mile up the creek a bar of weathered buff-coloured shale crosses the stream and forms a waterfall about 50 feet high, capped by gravels. It is at this waterfall that the large blocks in the bed of the stream, just referred to, are quarried. These buff-coloured shales were probably, originally, dark coloured (as occur elsewhere in the neighbourhood), but have been bleached by weathering.

So far as observed, these very thick gravel beds show little variation as to the kinds of stone they contain. The beds are horizontal and consist of clay, sandy clay, and stones. The majority of the latter are light coloured, siliceous, and saccharoidal quartzites, which are a common feature as bedding in the Cambrian Series. There are also a considerable number of the greyish-coloured shales, and a few bluish, very siliceous, and rather coarse-grained quartzites, but limestones are very rare. At the outlet, where the creek debouches on the beach, a few rather large limestone boulders occur, but these are not always to be seen, as they are sometimes covered either by sediment brought down by the creek or by sand washed up by the tide. At one place in the creek a block of the bluish, coarse-grained quartzite occurred, *in situ,* 2 feet in length. At a few horizons there are layers of larger stones that measure from 1 foot to 18 inches in length, but the majority of the stones composing the gravel beds do not exceed 6 or 9 inches, and by far the greater number are less than 6 inches in diameter. Clay is often mixed with the gravel. The pebbles usually show some wear, but not generally excessive, being mostly of subangular outline. At one place, along the cliffs, near the high-pitched Tertiary beds, there is a section showing large rounded stones.

On the southern side of the creek there are several small outlets to the drainage, but all of these are confined to the face of the gravel cliffs and are the effects of rain wash on the cliffs. In these small gutters the stones are similar to those in the main creek, mentioned above; that is, mainly, fine-grained, light-coloured quartzites and some bluish quartzites and buff-coloured shales, but no limestones.

The high gravel cliffs, facing the sea, extend for about a mile in length. The material is banked against the Cambrian outcrops, on the southern side, at a high cliff face, but the exact junction is obscured on account of a talus. The alluvial beds are undergoing rapid waste, occasioned by rain wash, soakages from behind, and numerous landslips, showing many remarkable features of earth sculpture as peaks, recesses, and slopes of various angles in a most picturesque manner. The waste from these alluvial cliffs has given rise to extensive shingle-banks on their northern side and to beach-travelled stones that are in evidence far up the Gulf.

The Sellick's Hill Creek (that crosses the main road a little south of the hotel) has cut its bed in the Cambrian shales, and, for some distance, the latter

are capped by thick beds of conglomerate that are strongly cemented by calcareous and ferrugineous material. On the paddock in front of the hotel are a great number of well-rounded and perfectly smooth highly-siliceous pebbles scattered over the surface in a light sandy soil. These have probably had a different origin from the thick gravels on the coast. The very fine grain of these rounded stones produces a conchoidal fracture and was no doubt the principal locality visited by the aborigines of the neighbourhood for obtaining material suitable for making their stone implements.

A very tenacious and compact white clay, thickly studded with angular fragments of white quartzites and some slates, is seen in the deep washouts on the cultivated lands, and especially in the Sellick's Hill Creek, near the township, a little below the main road. It is covered with newer alluvium that is not consolidated, and is of quite different appearance and colour from the former, being a dark-reddish sandy clay and stony alluvium. The division between the two is very sharp. A similar clay and contents appear on the beach near where the junction of the fossiliferous Tertiary beds with the Cambrian slates are seen in the cliffs, only here the clay is of a deep-red colour. It is covered, unconformably, by a very coarse river gravel. It looks as though it might have been a deposit laid down in a gorge cut in the fossiliferous Tertiary limestone. No base is seen to the red clay.

The origin of the thick gravel beds exposed in the cliffs facing the sea is not very apparent. They have certainly unique features and are of more than ordinary interest from being related to certain physiographical conditions that have long since passed away. The following points are worthy of note:—

1. The beds do not belong to the present system of drainage. The only creek that intersects the beds is the small creek, described above, but it is self-evident it has had no part in building up the great gravel sediments, as it is little more than a washout in these beds. The Sellick's Hill Creek flows in a different direction and is of insignificant dimensions.

2. The gravels belong to one system of deposition. They were laid down horizontally throughout, in uniform layers, that can often be traced for considerable distances, and are similar in composition throughout.

3. Near the top of the gravels is a thick layer (up to 30 feet) of the mottled clays and sands (? Pleistocene) containing angular and rounded stones. Thinner layers of mottled clay occur a little lower down, but towards the top. These are probably of a like age as the mottled beds at Hallett's Cove and elsewhere, and, like the latter, are covered by a newer clay bed of a brown or greenish colour.

4. The material of which the beds consist has evidently been derived from a local source, and from a direction in which the blue limestones and the archaeocyathidae limestones were not in the line of drainage. The latter limestones occur abundantly in the creeks that flow from the ranges in a northerly direction. Their absence from the gravels is rather peculiar in view of the fact that siliceous quartzites form the principal feature in the beds, and the latter mainly occur in outcrop behind the limestone beds.

5. It does not seem probable that the gravels were laid down by the Onkaparinga River, as the pebbles are restricted in their variety and have been laid down from another direction. If they had been brought down by the Onkaparinga they would have given evidence of greater wear.

6. The height above sea level (200 feet) and the horizontality of the beds indicate that at the time of deposition the land extended more to the westward. No base to the gravel beds is seen except where the fossiliferous limestones occur on the beach, but the latter may be an inlier of the gravels.

7. The smallness of the average stones in the gravel represents a somewhat low velocity in the transporting streams together with considerable width and uniform conditions.

8. Perhaps the phenomena can be best explained by assuming an extensive talus, fed by screes (such as exist on Mount Remarkable), and the material redistributed by local streams. The latter would probably unite and form a junction with the older outlet of the Onkaparinga, further to the westward.

9. The age of the beds cannot be very definitely defined. The great thickness of the alluvium is suggestive of the beds having been laid down during the period when the country was slowly sinking and the Onkaparinga was aggrading its bed by which the valley was filled up to the crest on its northern side. This movement of depression may have had some relation to the gradual development of the great "rift" which gave the adjacent Tertiary rocks a vertical pitch. As the gravels are covered by the mottled clays and sands (which are regarded as of Pleistocene age) the whole section may possibly be Pleistocene, or the gravels may be of greater age than the mottled beds but newer than the fossiliferous (Miocene) beds.

10. The section is not likely to retain its bold and vertical outlines for any great length of time. The rain is causing a rapid waste on the cliff face, and, as a result of such weathering action on their upper portions, a secondary cliff is being formed between the retreating heights and the beach, and on the ledges separating the two vegetation is beginning to find a footing.

Miocene Beds in Section G.

The Miocene beds, which pass below sea level near Snapper Point, reappear on the coast nearly a mile to the northward of the small creek described above. Some exposures on the beach have heights up to 15 feet, and when seen in washouts along the base of the cliffs they reach a height of 20 feet. The rock, as a whole, is a finely triturated organic limestone, consisting mostly of polyzoal fragments. The stone is relatively soft and is easily undermined by the waves, a succession of caves has been excavated by the sea in the limestone along the whole length of its exposure. The limestone ceases to form a cliff section shortly before reaching the washout creek, but continues in exposure along the littoral, between tides, the rock forming a moderately flat floor along the beach. This feature continues until about opposite the first Waterfall Creek, at the northern end of Sec. 278, Hundred of Myponga. At a short distance up this creek is an isolated fragment of the fossiliferous bed which has a dip to the north-west at 40°. It then disappears for about a third of a mile, but reappears in the cliffs and on the beach with a high angle of dip, which reaches 90°, and in one instance is reversed.

The disturbed condition of the Tertiary beds in this locality is quite unique for Australia, and is one of the concomitants of the great throwdown in the rift valley of South Australia. After passing the ancient mouth of the Onkaparinga the beds begin to roll in curves of 15° to the south-east and north-west; they show an increased dip to 40° in the small Waterfall Creek, and then at a short distance, further to the south, become vertical. [For a more detailed description of these beds see Howchin, W., 1911.]

Cambrian Beds in Section G.

The Cambrian System, including slates, limestones, and quartzites, can be studied to advantage on the northern slopes of Sellick's Hill [Howchin, W., 1897.] Earthy slates (or shales) which occupy the lowest position in this section are seen just above the Sellick's Hill Hotel and in exposure in the adjacent creek, and reach the coast by a south-south-west strike. The slates are often of a very dark colour by the presence of carbonaceous material (up to 25 per cent.) which has led some persons to imagine that coal might be found in them. In many places the carbon has been oxidised and thereby changed the colour of the rock to white, grey, or pinkish. Evidences of such change in progress

can be seen working inwards by cracks and joints, the margins of such crevices being blanched, while the inner portions, between the cracks, retain their original black colour.

The Cambrian slates appear abruptly in the cliffs of the sea coast, on the southern side of the great alluvium deposits, in cliffs of about 150 feet in height. Juvenile features are present in the form of narrow gorges and two waterfalls in the slate. One of these has a fall of 80 feet, broken by a ledge after the first 20 feet. These waterfalls have probably been "hung up" by reason of the somewhat rapid retreat of the cliffs, or by faulting and downthrow towards the "rift."

The Cambrian beds forming the sea-cliffs, and for some distance inland, are extraordinarily fractured. There is close jointing in all directions, and what appears to be master-jointing, or slide faces, occur nearly parallel with the coast, with the result that there are very heavy and extensive landslips down to the beach, leaving smooth faces from which the masses have slipped. The Cambrian slates adjacent to the disturbed Tertiary beds have evidently been influenced by the same tectonic movements and have received a throwdown to the north-west, producing also a local system of jointing and intimate fracturing.

GENERAL REMARKS.

Disconformity between the Upper and Lower Marine Series.

In addition to the palaeontological evidence for an hiatus having existed between the deposition of these respective sediments there are certain physical considerations that point in the same direction, as stated below:—

1. A slight stratigraphical unconformity can be detected at Blanche Point and elsewhere.

2. The Miocene, or Lower Marine System, has a much wider geographical range than the Pliocene, or Upper Marine System.

3. The Pliocene sediments are not always coincident in their occurrence with the Miocene. Thus: (1) The Pliocene sometimes rests upon the Miocene, as in the metropolitan area, in sea-cliffs from Blanche Point to Snapper Point, in the cliffs of the River Murray, and in the sea-cliffs of Edithburgh. (2) It rests on the Permo-Carboniferous glacial beds at Black Point. (3) On a (?) Pre-Pliocene sand rock at Hallett's Cove and in the lower cliffs to the northward of Morphett Vale Creek. (4) In several instances it rests directly on the Cambrian beds, as at Marino, also a mile inland from Hallett's Cove, and on the top of the sea-cliff (purple slates) a little north of Rocky Point.

4. The Miocene System has been subjected to more extensive deformation, chiefly by faulting, which has caused a wider range in the matter of elevation than has been the case with the newer system.

It seems probable that after the thick sedimentation had taken place over most of southern Australia, during Miocene times, the sea retreated, on the elevation of the land, to the southward, and after a time made a brief return over a portion of its former area, and was then limited to shallow water that was especially productive of oysters.

The sediments laid down during the second incursion of the sea were of a calcareo-arenaceous nature. When the sea once more retreated, the calcareous portion of the sediments, under semi-dry conditions, was drawn to the surface and precipitated as a surface limestone which now forms the craggy, unfossiliferous limestone that overlies the fossiliferous sandstones.

The (?) Pre-Pliocene Sand Rock.

The peculiar sandy and clayey bed, of a whitish colour, that underlies the Lower Pliocene, in places, presents some difficulty in relation to its stratigraphical position. At Hallett's Cove it is absent from the section on the Black

Point platform, where the Pliocene bed rests directly on the glacial beds, but it puts on suddenly at the northern side of the Cove, where for some distance it makes a thick though variable bed underlying the Pliocene. It is absent where the Pliocene beds are seen resting on the Cambrian, at Marino, and is also absent from the cliffs to the northward of Rocky Point, where the Pliocene beds make a sharp plane of contact with the purple slates, yet, within a short distance, to the southward, it develops a considerable thickness inferior to the Pliocene. The possible relationship of this bed to a similar bed that occurs at Hallett's Cove, and also on Kangaroo Island, has been mentioned previously. The question is—there is a white sand rock underlying the fossiliferous Pliocene in some places while absent in others—Can all these white sand beds be referred to a common origin, or have they different origins? If the bed had been limited to the Hallett's Cove section it would no doubt have been referred without hesitation to the Glacial Series. On the other hand, if only the bed, occupying the same stratigraphical position near the outlet of the Morphett Vale Creek, had to be accounted for, the explanation that would come readiest to mind would be that it represents a residual portion of the Freshwater Series, that underlies the fossiliferous Miocene, which occurs in outcrop at no great distance to the southward. In such a case it must be assumed that the marine beds of the latter, and more or less of the underlying freshwater beds, had been removed by denudation before the fossiliferous Pliocene was laid down, and when the latter rests on Pre-Miocene rocks, it would follow that the whole of the freshwater beds, inferior to the Miocene, had been removed before the deposition of the Pliocene.

Tectonic Deformations.

The deformations of the Tertiary beds within the area under description have relation to the tectonic movements that have contributed towards shaping the present physiographical features of the country. The two main controlling factors in this respect are: *(a)* The subsidence of the land in the Adelaide basin, in successive segments, by which the Miocene beds have sunk below the surface at various levels and, subsequently, been covered by newer deposits. *(b)* The breaking up of the ancient peneplain into faulted earth-blocks that have produced the south-westerly slopes of the Mount Lofty and Willunga Ranges.

In sympathy with such regional dislocations the Tertiary beds within the area have taken on a general south-westerly dip. The regularity of this dip-slope is interrupted by a repetition of beds. At Witton Bluff the basal beds of the Tertiary system are exposed on the northern side of the Bluff with a gradual dip to the south-west which brings in the higher beds, ending with the Pliocene at sea level on the northern side of Pedler's Creek. On the southern side of Pedler's Creek an inlier of Cambrian beds once more brings the basal beds of the Tertiary systems to the surface, followed by another gentle dip-slope to the south-west which, from Blanche Point, brings in the higher members of the series ending with the Pliocene, once more down to sea level, near Snapper Point. This interesting feature of repetition of the Tertiary system no doubt owes its existence to an east and west fault with a downthrow on the north and an upthrow on the south. The remarkable occurrence of an isolated fragment of the fossiliferous Miocene on the line of fault is a corroboration of its existence, for this fragment lies directly between the topmost Tertiary bed on the northern side of Pedler's Creek and the lowest (freshwater) Tertiary bed on the southern. It therefore owes its existence to a trough fault.

The coast adjacent to Sellick's Hill forms a part of the great fault-block of the Willunga Ranges. The Miocene beds in this region were, originally, laid down horizontally on the broken edges of the Cambrian strata and were elevated to a considerable height at the plateau formation period. A remnant of this

high-level occurrence of the Miocene System is still preserved on the Hindmarsh Tiers, 900 feet above sea level (Howchin, W., 1911). What otherwise is left of these fossiliferous rocks in this faulted block is found on the beach, where they have come under the control of the great rift-valley subsidence and have been pitched down to the west in a vertical position.

Tate's Geological Map of the District.

In a paper by Tate and Dennant (1896) the first-named author, in plate ii., gives a geological sketch map of the coast extending from the mouth of the Onkaparinga River to Sellick's Hill beach. It is difficult to understand Tate's map. There was, in the first instance, an error in the geological occurrences and definitions which was corrected by an "erratum" slip in the following volume. Apart from the occurrence of blown sand, in a few places, Tate shows an uninterrupted surface exposure of "Older Tertiary" from the mouth of the Onkaparinga to Sellick's Hill beach. These fossiliferous rocks, however, rarely show at the surface, other than at the base of the cliffs on the sea front, and are in almost all cases covered by thick deposits of Pleistocene and Recent alluvia that form the upper portions of the cliffs. He does not distinguish between the Freshwater Series (which has a great development on the northern side of both Blanche Point and Witton Bluff) and the overlying fossiliferous marine beds. He places on the map an exaggerated extension of the so-called "Archaean," on the southern side of Pedler's Creek, and has not distinguished from these "Archaean" cliffs the very important outcrop of fossiliferous Miocene, which forms the main cliff for 100 yards in length, where he places the older rocks adjoining the southern side of Pedler's Creek.

Sea Encroachment.

That the sea is encroaching on the land is evident from most places on both sides of Gulf St. Vincent. Wide sea-platforms of hard rock exist between tide marks in many places, and at high water the waves very commonly wash the base of the cliffs or the heavy material left from recent falls from the cliffs. One of these cliff falls that occurred on the north side of the outlet of the Aldinga Creek in 1913 (see Howchin's Geology of South Australia, fig. 102, p. 116) has since been practically swept away by the waves, leaving only a few large and hard blocks on the beach as its residue. If the last local earth movement on the coast has been an upward one, as is generally supposed, then the elevatory movement must have spent itself; or, otherwise, the rate of marine denudation keeps pace with the movement of elevation in correspondingly reducing the beach level.

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DESCRIPTION OF PLATES XXII. TO XXVI.

PLATE XXII.

Fig. 1. View of the southern face of Blanche Point. The foreground shows the beach platform consisting of the fossiliferous Miocene. The same beds form the lower portion of the cliff up to three-fourths of its height. The upper part of the cliff is formed by the Lower Pliocene fossiliferous sands overlain by a white limestone. The base of the newer fluviatile beds is seen resting on the latter at the right-hand side of the picture.

Fig. 2. View taken from the top of Blanche Point Cliff, looking southwards, at the same level. The white-coloured Lower Pliocene limestone forms a platform and a white ridge, seen on the right-hand of the picture. On this platform the Pleistocene and Recent alluvia form a secondary cliff which is undergoing sculpture and waste by atmospheric weathering.

PLATE XXIII.

Fig. 1. Photograph of a raised beach of large stones now included within the area of the sandhills on the northern side of Pedler's Creek.

Fig. 2. An outlier (or butte) of the alluvial cliffs on the northern side of the outlet of Morphett Vale Creek. The main portion of the hill is composed of Pleistocene clays and indurated sands; a strong bed of sandstone forms the crest of the hill, and the white sand bed, underlying the Lower Pliocene bed, can be seen near the base of the hill, although somewhat obscured by talus. The hill is strikingly similar in outline to Crown Point Hill, on the Finke River, but is not so high.

PLATE XXIV.

Fig. 1. A view of the thick gravel beds that form the main cliff for about a mile in length on the coast, near Sellick's Hill, and are about 200 feet in height.

Fig. 2. Another view of the same gravel beds at a short distance from those shown in fig. 1.

PLATE XXV.

Geological section of the sea-cliffs from Brighton (bore) to the mouth of the Onkaparinga River.

PLATE XXVI.

Geological section of the sea-cliffs from the mouth of the Onkaparinga River to the beach near Sellick's Hill.

THE COMPOSITION OF THE WATERS OF THE GREAT AUSTRALIAN ARTESIAN BASIN IN SOUTH AUSTRALIA AND ITS SIGNIFICANCE.

By R. Lockhart Jack, B.E.

[Read August 9, 1923.]

During the last thirty years many analyses have been made of waters from springs and bores in the South Australian portion of the Great Australian Artesian Basin. The bulk of them are by W. S. Chapman, of the School of Mines, and the remainder by G. A. Goyder and W. A. Hargreaves, Government Analysts, and by Goyder and Hallett. The full analyses of samples taken prior to September, 1921, are to be found in the Reports of the Interstate Conference on Artesian Water for 1912, 1914, and 1921.

The writer, struck by the variation in quality, and particularly by the fact that the eastern waters carry carbonate in excess, while the western waters carry excess of sulphate over carbonate, set out certain characteristics of the analyses in map form, together with other data. Some very interesting features became obvious when this was done.

The maps prepared were (1) an isopotential map, on which the carbonic acid and the sulphuric acid radicles were also separately set out in grains per gallon of carbonic acid radicle present, or deficient, as shown by excess of the SO_4 radicle; (2) plans showing the total salts in grains per gallon; and (3) total chlorine in grains per gallon.

Curves of equal total salinity and of equal chlorine content were then plotted on these maps. It is much to be regretted that there are some bores and springs from which no analyses are available, and which would have enabled a wider area to be plotted. These samples will be got as opportunity arises and the maps modified. Taking No. 1 map first.

The isopotential[1] lines indicate, in addition to the influx of water from the north-east, that there is a western feeder, or intake, and examination of the salient features of the analyses tabulated on pages 319-321 shows clearly that there are two very distinct types of water in the basin—the carbonated and the sulphated. The carbonate water is the Queensland water, and the amount of carbonate increases as the water travels south-west. The greater part of this carbonate is assumed, in the analyses, to occur as sodium carbonate, and the sulphates are nearly or entirely absent. The other type of water may contain carbonates also, the bulk of which is assumed to be present as calcium carbonate, but the sulphates are always present in excess. In preparing No. 1 map the sulphuric and carbonic acid radicles (shown in analyses as grains per gallon) were alone considered. To compare them the weight of the sulphuric acid radicle is expressed in terms of the carbonic acid radicle according to their respective valencies. This may be illustrated more simply by an example of two common salts having the same metallic base (sodium, for instance) combined with the carbonic and sulphuric acid radicles. The quantity of sodium that is satisfied or enters into chemical combination with ten parts of the sulphuric acid radicle is satisfied by 6·3 parts of the carbonic acid radicle. So, to get comparable figures for plotting, a water containing 10 grains of sulphuric acid radicle is plotted as a deficiency of 6·3 grains of carbonic acid radicle. The analyses in which SO_4 predominate are plotted with the negative sign preceding the figure.

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(1) Using the heights of the surface above the sea, and the water pressures in the case of flowing bores, or the depth to water level in non-flowing bores, contour lines are drawn through as many points of equal elevation on the water surface as possible. These contours showing the height of the water surface—the isopotential lines—show the height to which water will rise in a new boring, and also the direction of movement of the underground water. This movement is at right angles to the isopotential lines; that is to say, down the steepest slope.

It will be seen that there is on the map what may be termed a Neutral Line; that is, a line where the equivalent quantity of the sulphuric is equal to that of the carbonic acid radicle. This line approximately indicates the meeting of the eastern and western waters. The gradual relative decrease in SO_4 from west to east is probably accounted for by the interchange of alkali sulphates and carbonate of lime in the aquifer giving soluble alkaline carbonates and gypsum which is held in the porous sand beds. For example, the Arckaringa water contains less gypsum as it is followed eastward, and it is very probable that if this water travelled as far as the eastern water has done it would be wholly carbonate and not sulphate. The Neutral Line lies east of Anacoora and Allinga Bores, west of Dalhousie Springs, east of Horseshoe and Oodnadatta Bores, and thence east of the Denison Range, to between Strangways and Coward Bores. The line is a fluctuating one, its position depending on the relative draught on and intake of the eastern or western water. As plotted, out of the total area of the South Australian portion of the Artesian Basin, of 106,740 square miles, 22,200 square miles, or 26·4 per cent., is fed by the western water.

On the plans are marked, as small crosses, all the groups of mound springs that are named on the South Australian 16-mile map, and the relation of the iso-potential lines to them is very marked. A map of the Great Basin, prepared by L. K. Ward and published in the "Annual Report of the Government Geologist for 1921," shows that in the Eastern States there is a similar and marked fall of potential near the mound springs, and leaves no room for doubt as to the springs having been the normal main escape vents for the water before boring was started. Plans Nos. 2 and 3 show two sets of data: the total salts and the chlorine, in grains per gallon.

These isopleths of salinity and the iso-chlors agree on the whole very closely and bring out several features that were not apparent on the first plan. They show the good quality of the eastern water, and that it gradually increases in mineral content as it travels westward.

The exceedingly variable character of the western intake water is made clear. The Goyder and Finke and Alberga feeders draining from high land, and so, being large, give good water. As it travels underground towards its natural outlets (the Mound Springs west of the Denison Ranges) it becomes worse in quality, partly no doubt by the solution of material in its path and partly by admixture of the lower-quality waters from the upper Arckaringa and southerly intakes, which are seeking the same outlet. The Arckaringa feeder is less efficient and so the water is of poorer quality. Thence to the Stuart Range Bores the quality is bad, as is only to be expected from the absence of run off and the scanty rainfall. These maps also show very clearly that there is an intake west of Strangways, where Warriner and North Creeks supply poor-quality water of the sulphate type. This tongue of bad water thrust into the better-quality eastern water gradually becomes diluted.

The most significant is the great tongue of good-quality water that makes its way past Jewellry Creek Bore to the Bopeechee-Coward groups of springs. A less-defined one leads towards Petermorra and Paralana Springs, and there is also a tongue of good water extending from the east towards the springs between Lake Eyre and Denison Ranges.

The total salinity isopleths and isochlors have very great significance, as they indicate that there is a very pronounced differential movement in the underground water, and that this movement is towards the natural outlets. Furthermore, it argues the antiquity of these outlets, as the water flowing directly from intake to outlet has had time to flush out zones through the older and more stagnant and consequently more highly mineralized water, and to refill them with fresher water.

Still another deduction that may reasonably be drawn is the very considerable

bulk of water that must be stored in the sands, else the draught of many large bores would have distorted the tongues of good water still leading direct from intake to outlet.

It will be noted that, with one exception, neither the isopotentials nor the chemical data so far indicate any definite intake between Marree and the eastern border. At Cat Spring, to the north of the Flinders Range, the water is of the sulphated artesian type, and can only come from a local intake, which, however, may extend for some distance towards Marree. Yerilla and Lake Crossing Bores, which are not deep enough to get the main or carbonated supply, must derive their sulphated water from a western intake into some bed above the main water-bearing horizon, and this water must come from the slopes of the Flinders Range.

Montecollina, which just touched the water-bearing bed, has worse water than should be normal for the locality, though it has improved since first struck. This improvement is a feature of several bores, and the writer suggests that as the water just below the shale is probably more stagnant than in the main sand body it has retained more salts, and that this more saline water is gradually replaced by better water flowing from below towards the bore.

Other bores again, though apparently deep enough (*e.g.*, Gypsum), show water so bad for their locality as to suggest contamination by the low-grade ground water which may have corroded the casing or got down past it.

The plans all go to show the significance of the mound springs in considering the artesian supplies.

The flow of these springs, numerous though they are, cannot be compared with the flow from the thousands of bores now sunk in the basin in Queensland, New South Wales, and South Australia, and as there is no evidence that the springs were much stronger immediately before the inception of boring, it follows that the annual intake, at that time, approximately balanced the escape through the mound springs and beneath the Gulf of Carpentaria, and that the draught of the bores is on accumulated water stored in the more elevated portion of the main water-bearing bed, and which high-level water increased the potential throughout the basin. With the lowering of potential that is now going on, more and more of the bores throughout the basin will only yield by pumping what water is actually required, and the escape from the mound springs and into the Gulf of Carpentaria will also fall off from the same cause, so that ultimately there will come a new state of balance, in which the influx of water will meet the demands of pumped bores, of the diminished spring and bore flows, and of the leakage into the Gulf. What amount of water actually enters the intake is impossible of computation. Prior to the inception of boring, when the potential was probably not less than 10 per cent. or more than 20 per cent. greater than it is to-day, there would be a correspondingly greater escape by the natural vents of an additional quantity that nevertheless could easily escape observation. The present draught has diminished this escape and is still lowering the potential. When the new state of balance arrives the lowered potential will have further decreased the escape by natural vents, and it is only reasonable to suppose that the additional absorption capacity of the drained intake beds will permit of an annual accession greater than existed before boring began. The annual available supply in the future may thus be confidently counted upon as being considerably greater than the escape from the outlets of the basin just prior to the sinking of the first bore.

Unfortunately there is no way of controlling the flow of these outlets.

South Australia, having the lowest elevation, will be the least and last affected, but meanwhile rigid control to prevent waste of water from the bores will help to defer the loss of the accumulated stores of water, and delay that extension of widespread, expensive, and deep pumping which will follow when the residents of the basin are dependent on the average annual income of water.

	Date.	Total salts grs. per gall.	Chlorine grs. per gall.	CO_3 grs. per gall.	SO_4 grs. per. gall.	CO_3 equivalent of SO_4 grs. per gall.	Excess or deficiency of CO_3 grs. per gall.
Abdul (Marree)	21/1/15	141·31	47·35	34·71	Nil	Nil	34·71
Allinga	16/11/22	53·69	19·74	4·80	8·94	5·63	— ·83
Anacoora	1900	61·40	22·00	5·31	9·58	6·04	— ·73
Anna Creek	1891	366·33	176·22	10·02	42·81	26·97	—16·95
Appatina	20/2/22	70·42	17·08	8·25	17·84	11·24	— 2·99
Appreetinna	30/11/22	378·92	165·81	7·65	71·69	45·16	—37·51
Apperinna	28/6/23	146·13	58·06	9·30	22·12	13·94	— 4·64
Bangaboorana	18/2/15	361·10	146·51	10·05	77·22	48·65	—38·60
Billa Kalina Sp.	1891	366·15	165·97	35·11	29·07	18·31	16·80
Birribirriana	26/2/15	169·81	61·77	9·30	36·50	22·99	—13·69
Blanche Cup Sp.	1891	282·40	132·58	29·16	10·46	6·59	22·57
Blood's Ck.	16/11/22	77·44	30·62	4·20	13·92	8·77	— 4·57
Bopeechee Sp.	1891	178·28	60·48	37·14	9·02	5·68	21·46
Breaden	16/11/22	139·22	49·22	10·65	27·68	17·44	— 6·79
Brown's Ck.	28/6/23	165·11	68·25	9·90	23·52	14·82	— 4·92
Cadnaowie Sp.	1891	163·50	59·85	10·44	30·37	19·13	— 8·69
Cannuwaukaninna	5/10/16	85·83	17·63	28·40	·12	·08	28·32
Cannuwaukaninna	16/11/22	72·96	14·31	26·70	Nil	Nil	26·70
Cat Sp.	1891	317·56	119·42	22·18	56·89	35·84	—13·66
Clayton	30/9/22	76·10	10·81	31·95	·37	·23	31·72
Clayton Dam	5/12/14	118·46	30·14	36·00	2·10	1·30	34·70
Clayton Dam	15/12/22	118·29	29·73	36·30	2·31	1·45	34·85
Corryaninna	5/12/14	70·81	9·55	29·61	Nil	Nil	29·61
Cooinchina	25/5/23	385·11	184·24	10·05	45·44	28·63	—18·58
Cootanoorinna Sp.	26/2/15	216·17	83·05	13·80	40·95	25·80	—12·00
Coward	1891	252·74	106·12	34·62	13·27	8·36	26·26
Coward	1894	245·50	102·20	34·63	12·57	7·92	26·71
Coward	13/2/15	233·62	95·80	36·30	7·74	4·88	31·42
Coward	27/10/22	230·11	93·62	34·80	10·75	6·77	28·03
Coward Sp.	1891	239·22	97·44	34·14	13·92	8·77	25·37
Culberta	31/1/22	116·19	31·63	35·85	·62	·40	35·25
Dalhousie Homestead Sp.	1913	79·17	31·16	16·67	Nil	Nil	16·67
Dalhousie Hot Sp.	1913	62·39	23·82	7·20	7·00	4·41	2·79
Dulkaninna	1898	65·95	8·16	29·99	Nil	Nil	29·99
Dulkaninna	30/9/22	67·98	8·04	29·55	·45	·28	29·27
Emerald Sp., 50,000 g.p.d.	23/5/23	263·55	110·27	30·90	20·47	12·90	18·00
Francis Sp.	1891	373·61	179·34	9·66	45·16	28·45	—18·79
Fred's Sp.	1891	125·73	36·68	36·18	1·61	1·01	35·17

	Date.	Total salts grs. per gall.	Chlorine grs. per gall.	CO_3 grs. per gall.	SO_4 grs. per gall.	CO_3 equivalent of SO_4 grs. per gall.	Excess or deficiency of CO_3 grs. per gall.
Giddigiddinna Sp.	17/10/19	273 34	115 59	10 65	50 14	31 59	—20 94
Glenmanyie	31/8/21	140 19	29 62	49 35	3 29	2 07	47·28
Goyder's Lagoon	1905	56 20	5 04	23 26	Nil	Nil	23 26
Gypsum	16/11/22	502 75	271 85	1 50	52·08	32 81	—31 31
Hamilton	1896	112 79	43 80	8 39	19 33	12 18	— 3 79
Hamilton	28/4/14	80 46	28 36	6 30	14 58	9 19	— 2 89
Hamilton	16/11/22	84 51	32 62	6 30	14 62	9 21	— 2·91
Hawker's Sp.	5/6/23	329 58	153 88	8 25	44 74	28 25	—20 00
Hergott Rly. Yard	Dec. 1909	212 00	92 00	31 37	·82	52	30 85
Hergott (Marree)	Dec. 1909	162 22	57 00	35·92	Nil	Nil	35·92
Hergott Sp.	1891	157 22	46 41	42 36	Nil	Nil	42 36
Hope Ck.	5/6/23	329 47	157 37	8 70	40 37	25 40	—16·70
Horseshoe (Macumba)	1913	169 96	67 96	8 70	28 42	17·90	— 9·20
Horseshoe	28/6/23	167 13	67 55	9·60	26 94	17 98	— 7 38
Imbitcha	13/2/15	279 14	109 20	9 15	63 28	39·87	—30·72
Imbitcha	12/11/22	260 75	106 13	6 15	58 46	36 84	—30·69
Jewellry Ck.	5/12/14	66 83	8 07	28 68	Nil	Nil	28 68
Kopperamanna	1898	55·03	10 35	21 64	Nil	Nil	21 64
Kopperamanna	16/11/22	72·71	15 74	25 35	Nil	Nil	25 35
Lake Crossing	1897	735 38	364 00	4 20	82 86	52 05	—48 85
Lake Harry	1896	92 08	18 15	35 32	Nil	Nil	35 32
Lake Harry	1909	96 20	17 80	34 84	Nil	Nil	34 84
Lake Harry	30/9/22	95 12	18 99	35 40	33	21	35 19
Lake Letty	10/8/21	96 14	17 91	37 85	Nil	Nil	37 85
Little Perry	5/6/23	235 49	106 78	7.20	33 66	21 25	—14·05
Macumba H.S.	28/6/23	205·01	93 87	8 25	24 39	15 36	— 7 11
McLeod's	13/2/15	272 88	100 59	9 30	67·94	42 80	—33 50
McLeod's	16/11/22	270 13	100 16	9 30	67 44	42 49	—33 19
Meteor	5/12/14	86 98	11 78	36 00	24	15	35·85
Mirackina	8/3/15	250 04	90 80	10 65	59 99	37 79	—27 14
Milne	5/6/23	164 46	67 00	10 05	25 21	15·90	— 5 85
Molehill Sp.	26/2/15	193 77	73 26	9·00	42 18	26 57	—17 57
Montecollina	11/9/20	280 36	156 60	10 05	3 33	2 10	7·95
Montecollina	15/12/22	273 93	131 50	11 10	Nil	Nil	11 10
Mt. Hamilton Sp.	1891	308 47	137 76	26 22	25 26	15 91	10 31
Mother's Well	21/2/22	145 03	46 01	8 85	39 10	24 63	—15 78
Mungeranie	1900	62 80	5·90	25 52	Tr	Tr	25 52
Murnpeowie	Mar., 1912	104 00	28 20	20 70	10 95	6 75	13 95
Murnpeowie	May, 1912	83 80	14 40	32 35	1 67	1 05	31 30
Murnpeowie	Sept., 1912	117 03	13 70	51 14	2 57	1 62	49 52
Murnpeowie	Sept., 1912	124 18	14 10	54 70	1 88	1 18	33 52

Murnpeowie	5/12/14	84 91	14 18	32 40	1 44	91	31 49
Murnpeowie	15/12/22	86 44	15 58	31 05	2 64	1 66	29 39
Nilpinna One Mile	8/3/15	145 08	52 98	9 60	28 80	18 14	— 8 54
Nilpinna Four Mile	26/2/15	161 48	58 88	10 20	32 92	20 74	—10 54
Nilpinna Five Mile	8/3/15	163 72	58 47	10 80	33 29	20 97	—10·17
Nilpinna Garden	26/2/15	148 77	53 88	9·90	30 49	19 21	— 9 31
Nilpinna House	26/2/15	149 08	53 89	9 90	30 62	19 29	— 9 39
Nilpinna Sp.	1891	201 67	72 27	16 14	41 15	25 92	— 9 78
Opossum	16/11/22	56 02	22 89	4 05	7 95	5 01	— ·96
Oodnadatta	1894	125 59	48 50	9 29	21 87	13 78	— 4 49
Oodnadatta	1910	131 70	50 40	9 60	21 45	13 51	— 3 91
Oodnadatta	14/2/11	129 50	47 70	9 57	20 57	12 96	— 3 49
Oodnadatta	8/3/15	125 99	49 04	16 20	11 29	7 11	9 09
Oodnadatta	16/11/22	127 60	48 50	9 45	21·96	13 83	— 4·38
Paralana Hot Sp.	1913	77 72	22 50	10 35	10 56	6 65	3 70
Peachawarrinna	30/9/22	109 90	32 99	30·30	24	15	30 15
Petermorra	14/11/22	75 97	14 01	29 40	Nil	Nil	29·40
Piarooka	5/6/23	1006 56	794 25	5 70	47 76	30 00	—24 03
Primrose Sp.	5/6/23	202 07	88 63	11 70	25 95	16 03	— 4·60
Quart Pot	5/12/14	81 74	11 05	34 50	Nil	Nil	34 50
Raspberry Ck.	26/2/15	224 95	82 91	10 20	52 65	33 17	—22 97
Raspberry Ck.	16/11/22	223 23	81 84	9 30	54 26	34 18	—24 88
Snake Ck.	28/6/23	134 21	52 62	8 55	21 09	13 29	— 4 74
Spring Hill Sp.	5/6/23	284 79	131 20	7·65	39 59	25 00	17·35
Stevenson	16/11/22	142 49	51 22	9 45	28 76	18·12	— 8·77
Strangways	8/3/15	393 69	192 10	15 15	35 02	22 06	— 6·91
Strangways Sp.	1891	416 53	203 84	15 24	39 02	24 58	— 9 34
Stuart Ra., No. 1	6/5/20	1329 36	621 12	Nil	240 32	151 40	—151 40
Stuart Ra., No. 2	16/9/20	351 58	149 29	6·60	70 70	44 54	—37·94
Stuart Ra., No. 2	15/1/21	275 67	113 12	5 40	58 01	36 55	—31 15
Sulphur Sp.	1891	429 47	197 54	25 93	45 57	28 71	— 2 78
Thora Soak, Bore East of	5/6/23	161 37	65 60	10 95	23 75	14·60	— 3·65
Thurlooka	31/1/22	123 07	26 71	44 25	62	40	43 85
Troudininna	5/12/14	68 54	8 17	29 52	Nil	Nil	29 52
Warrangarrana	13/2/15	224 86	91 79	13 95	37 39	23 56	— 9 61
Weedina Sp.	1891	256 87	103 74	18 55	48 68	30 67	—12 12
Weedina Sp.	8/3/15	264 92	109 77	10 80	49 07	30 91	—20 11
William Ck.	13/2/15	353 48	167 48	8 20	44 41	27 98	—19 78
William Ck.	24/10/22	354 25	168 31	9 00	43 84	27 62	—18 62
William Ck. Rly.	1913	365 25	168 48	9 60	42 84	26 99	—17 39
William Ck. Stn.	1913	351 17	167 74	13 50	35 92	22 63	— 9 13
Wire Ck. (Storm)	16/11/22	148 39	54 94	10 05	26 45	16 66	— 6 61
Wood Duck	5/6/23	149 08	59 32	9 60	23 28	14 70	— 5·10
Woolatchi	12/7/16	141 20	?	55 98	Nil	Nil	55 98
Yarra Hill	5/12/14	83 27	14 26	32 10	Nil	Nil	32 10
Yerilla	15/7/15	889 73	431 59	[illegible]	125·74	79 22	—76 91

THE DISTRIBUTION OF AUSTRALIAN ORCHIDS.

By R. S. Rogers, M.A., M.D.

[Read October 11, 1923.]

1. Introductory.

In a country so vast as Australia, with its three million square miles of territory, its many inaccessible parts, and its small band of scientific workers, it is hardly to be expected that the investigation of its flora should have approached completion. Undoubtedly the spade-work was long ago accomplished, but botanical exploration of the less trodden areas and the hand of the specialist in many families, still await realization.

So far as the orchids are concerned, although they have attracted much attention, it may be confidently asserted that no State in the Commonwealth has yet been critically examined. A great deal still remains to be done in tropical Queensland, still more in Western Australia, and almost everything in the Northern Territory, before even such a fundamental question as their distribution can be satisfactorily decided. This family occupies fifth rank in numerical importance on our census of plants, and it is obviously desirable that such a matter should be established as accurately and as early as possible. On it may depend to some extent, the solution of much greater questions concerning the former disposition of land masses, the origin of our flora, and the true relation of our continent to other portions of the globe.

The distribution of our Orchidaceous flora is chiefly coastal in character, the greater portion of the interior of the continent being too arid to support vegetation of this type.

An annual rainfall of at least 10 inches would appear to be essential for the maintenance of all but a few members of the family. Some of the latter, however, belonging to the terrestrial genera *Caladenia, Thelymitra, Pterostylis, Diuris,* and *Microtis* have been recorded well within this belt of rainfall in South Australia, and even from such an unlikely region as the Great Victoria Desert in the West. Such adaptability is particularly surprising in the case of *Pterostylis,* a genus with naked tubers and shade-loving habits, which one would consider quite unsuited physically to resist drought and other desiccating influences.

The family is represented in Australia by 64 genera and about 450 species. Nineteen of the former are epiphytal and also nearly a fourth of the latter, Such orchids are usually confined to the tropical or subtropical parts, but a few penetrate as far south as Victoria, and one even reaches the 42nd parallel of latitude in Tasmania; none are found in South Australia, and only two have been reported from the large State of Western Australia, both of them from the Kimberley district in the extreme north of that State.

The vast majority of the terrestrial forms belong to the tribe Neottieae, the other tribes being poorly represented by a few small genera, with the exception perhaps of the tropical genus *Habenaria,* which contains 15 species, and is a member of the Ophrydeae.

Compared with the dense orchid population of New Guinea and some other countries, our flora cannot be considered a rich one.

The following tables[1] will make this clear:—

Orchid Flora of	Approximate area in square kilometres.	Total number of species.
1. Australia	7,700,000	circa. 450
2. New Guinea	786,000	2,205
3. Java	126,000	600
4. Tropical Africa	6,000,000	750
5. Brazil	8,468,950	1,850
6. British India	4,809,100	1,500
7. Central America	2,400,000	2,000
8. Japan and Liukiu Islands ..	382,300	147
9. Philippines	300,400	723

Orchid Flora of	Average number of square kilometres to each species.
1. Australia	17,111
2. New Guinea	356
3. Java	210
4. Tropical Africa	8,000
5. Brazil	4,579
6. British India	3,206
7. Central America	1,200
8. Japan	2,600
9. Philippines	415

In instituting such comparisons, it is necessary to take into consideration the very large unoccupied central area of the continent, which Sir Joseph Hooker[2] estimated as two-thirds of the total superficies, and which he believed to be incapable of bearing vegetation on account of its arid character. In the light of modern knowledge, it is now known that this area is by no means unproductive for many forms of plant-life, but that owing to its low rainfall and absence of large waterways, it does not carry an orchid-flora. Consequently Hooker's statement still remains approximately true so far as this type of vegetation is concerned.

Due allowance, therefore, having been made for this fact, the fertility of the orchid-bearing areas may be roughly estimated at 5,700 square kilometres per species, a result which is comparable to that of Brazil, a tropical country rather larger than our own.

2. Flora of Exotic Origin.

So far as it has been investigated, the orchid-flora of tropical Australia bears a very close relationship with that of Southern Asia, and particularly to that of the Malay Peninsula and New Guinea.

From North-western Australia, only three orchids have so far been reported. The three genera to which they belong are to be found in Asia; one of the species also occurs in New Guinea and another is sectionally represented there.

The Northern Territory has disclosed up to the present only 12 genera and 22 species. Eleven of the former are to be found in the Malay Archipelago or in New Guinea; in those places also five of the species occur and others have sectional representation.

The same thing happens in the case of tropical Queensland, where out of 53 genera no less than 41 are in common with New Guinea or the Archipelago, and usually with both stations.

(1) Adapted from Schlechter's "Orchidaceen von Deutsch-Neu-Guinea," p. xv.

(2) "Flora Tasmaniae, Introductory Essay," p. xxx.

Thus out of 64 genera which constitute the orchid population of Australia, 43 are known to exist in the above stations, about 22 of the species appear to be conspecific, and others have close relationships.

This will be more clearly understood from the following lists:—

Genera common to Tropical Australia and

New Guinea.	Malay Archipelago.
Microstylis, Nutt.	*Microstylis*, Nutt.
Oberonia, Lindl.	*Oberonia*, Lindl.
Liparis, Rich.	*Liparis*, Rich.
Dendrobium, Sw.	*Dendrobium*, Sw.
Bulbophyllum, Thou.	*Bulbophyllum*, Thou.
Cirrhopetalum, Lindl.	——
Osyricera, Bl.	——
Eria, Lindl.	*Eria*, Lindl.
Phreatia, Lindl.	*Phreatia*, Lindl.
Phaius, Lour.	*Phaius*, Lour.
Pholidota, Lindl.	*Pholidota*, Lindl.
Spathoglottis, Bl.	*Spathoglottis*, Bl.
Calanthe, R. Br.	*Calanthe*, R. Br.
Eulophia, R. Br.	*Eulophia*, R. Br.
Cymbidium, Sw.	*Cymbidium*, Sw.
Geodorum, Jacks.	*Geodorum*, Jacks.
Dipodium, R. Br.	*Dipodium*, R. Br.
Luisia, Gaud.	*Luisia*, Gaud.
Phalaenopsis, Bl.	*Phalaenopsis*, Bl
Sarcochilus, R. Br.	*Sarcochilus*, R Br.
Cleisostoma, Bl.	*Cleisostoma*, Bl.
Ornithochilus, Wall.	——
Taeniophyllum, Bl.	*Taeniophyllum*, Bl.
Galeola, Thou.	*Galeola*, Thou.
Corymbis, Thou.	*Corymbis*, Thou.
——	*Anoectochilus*, Bl.
Spiranthes, Rich.	*Spiranthes*, Rich.
Hetaeria, Bl.	*Hetaeria*, Bl.
Zeuxine, Lindl.	*Zeuxine*, Lindl.
Goodyera, R. Br.	*Goodyera*, R. Br.
Pachystoma, Bl.	*Pachystoma*, Bl.
Nervilia, Comm.	*Nervilia*, Comm.
Didymoplexis, Griff.	*Didymoplexis*, Griff.
——	*Thelymitra*, Forst.
Cryptostylis, R. Br.	*Cryptostylis*, R. Br.
——	*Microtis*, R. Br.
Corysanthes, R. Br.	*Corysanthes*, R. Br.
Pterostylis, R. Br.	——
——	*Caladenia*, R. Br.
Gastrodia, R. Br.	*Gastrodia*, R. Br.
Epipogum, Gmel.	*Epipogum*, Gmel.
Habenaria, Willd.	*Habenaria*, Willd.
Vanda, Jones	*Vanda*, Jones
Apostasia, Bl.	*Apostasia*, Bl.

Orchids of Tropical Australia conspecific with species in

New Guinea.	Malay Archipelago.
Eulophia venosa, Rchb. f.	——
——	*Nervilia flabelliformis*, Lindl.
——	*Didymoplexis pallens*, Griff.
Geodorum pictum, Lindl.	——
Vanda Hindsii, Lindl.	——
Dendrobium bifalce, Lindl.	——
D. undulatum, Br.	——
D. Gouldii, Rchb. f.	——
D. gracilicaule, F. v. M.	——
D. Smilliae, F. v. M.	——
D. Johnsoniae, F. v. M.	——
——	*Oberonia iridifolia*, Lindl.
——	*Phaius grandifolius*, Lour.
Pholidota imbricata, Lindl.	*Pholidota imbricata*, Lindl.
Calanthe veratrifolia, R. Br.	*Calanthe veratrifolia*, R. Br.
——	*Luisia teretifolia*, Gaud.
Corymbis veratrifolia, Richb. f.	*C. veratrifolia*, Rchb. f.
——	*Spiranthes, australis*, Lindl.
——	*Goodyera viridiflora*, Bl.
——	*Microtis parviflora*, R. Br.
——	*Caladenia carnea*, R. Br.
Epipogum nutans, Lindl.	*E. nutans*, Lindl.

In addition to these conspecific orchids there are a number which are sectionally represented in New Guinea, such, for example, as *Oberonia palmicola*, F. v. M.; *Dendrobium bigibbum*, Lindl.; *D. dicuphum*, F. v. M.; *D. Sumneri*, F. v. M.; *D. phalaenopsis*, Fitzg.; *D. superbiens*, Fitzg.; *D. aemulum*, R. Br.; *D. tetragonum*, A. Cunng.; *D. Moorei*, F. v. M.; *Sarcochilus falcatus*, R. Br.

When we consider these lists, we are forced to the conclusion that we are dealing with an almost exclusively immigrant flora, which in all but a few instances can be traced back into Asia proper. This flora of exotic origin, would appear to comprise about two-thirds of the entire genera of our continent.

It is also evident, from the comparatively small number of species in common, that this flora has been resident in Australia sufficiently long to allow a considerable amount of differentiation to take place.

On the other hand, judging from the very few Australian types, such as *Microtis*, R. Br.; *Thelymitra*, Forst.; *Caladenia*, R. Br.; and possibly *Dipodium*, R. Br., to be found in the Malayan flora, the emigration northwards must have exerted only a slight or negligible influence.

Some of the better developed Papuan and Malayan genera are but weakly represented in Australia, and others not at all. For example, in German New Guinea alone, *Phreatia*, *Taeniophyllum*, and *Microstylis* number 75, 59, and 48 species, respectively, whereas with us they are monotypic; on the other hand, *Agrostophyllum* and *Glossorhyncha*, each with 32 species, are unknown in this country.

It is also somewhat surprising, that situated so closely as it is to the great developing centre for *Dendrobium* and *Bulbophyllum* in New Guinea, we should not be better represented in species belonging to these prolific genera. At least 500 Papuan species of each of them have been described, and yet in the whole of our continent, there have only been recorded 48 species of *Dendrobium* and 16 of *Bulbophyllum*.

On the other hand Schlechter[3] states, that he and Dr. J. J. Smith have traced in New Guinea several species of the Section Rhizobium, belonging to *Dendrobium,* which occur under exceptionally dry conditions for New Guinea, and which without doubt point to an Australian origin.

Two species of *Pterostylis,* R. Br., which is unquestionably an Australian type, have also been recorded in that island, both from alpine localities; one, *P. papuana,* Rolfe, at a height of 12,200 feet in British Papua, and the other, *P. novo-guineensis,* Ridley, at a height of from 8,000-11,000 feet in Dutch Territory. Both of these have a strong resemblance to existing Australian species.

It is noticeable from our tables, that every epiphytic genus recorded in Tropical Australia occurs also in the Archipelago or in New Guinea; and further, that the balance of those orchids common to these floral regions, and consisting of terrestrial types, are about twice as numerous as the epiphytes.

In the large islands lying north of the Equator, the Papuan-Malay elements of our flora are still in strong evidence. This may be most easily studied in the Philippines, where Mr. Oakes Ames[4] has submitted a vast amount of orchidaceous material to critical examination. He says, however, in regard to these islands, that "there are still large areas, botanically unknown, from which it is highly probable that rich accessions to our orchid herbaria will be made."[5] He admits 101 genera with 723 species.

An examination of these genera shows that no less than 38 of them are shared in common with Australia. These are as follows:—

1. *Habenaria,* Willd.
2. *Thelymitra,* Forst.
3. *Microtis,* R. Br.
4. *Cryptostylis,* R. Br.
5. *Galeola,* Lour.
6. *Epipogum,* Gmel.
7. *Nervilia,* Comm.
8. *Didymoplexis,* Griff.
9. *Gastrodia,* R. Br.
10. *Corysanthes,* R. Br.
11. *Spiranthes,* Rich.
12. *Goodyera,* Bl.
13. *Anoectochilus,* Bl.
14. *Cheirostylis,* Bl.
15. *Hetaeria,* Bl.
16. *Corymbis (Corymborchis),* Thou.
17. *Pholidota,* Lindl.
18. *Microstylis (Malaxis),* Nutt.
19. *Oberonia,* Lindl.
20. *Liparis,* L. C. Rich.
21. *Phajus,* Lour.
22. *Calanthe,* R. Br.
23. *Spathoglottis,* Bl.
24. *Pachystoma,* Bl.
25. *Eulophia,* R. Br.
26. *Goodorum,* Jacks.
27. *Dendrobium,* Sw.
28. *Eria,* Lindl.
29. *Bulbophyllum,* Thou.
30. *Phreatia,* Lindl.
31. *Dipodium,* R. Br.
32. *Cymbidium,* Sw.
33. *Sarcochilus,* R. Br.
34. *Phalaenopsis,* Bl.
35. *Luisia,* Gaud.
36. *Vanda,* Jones
37. *Cleisostoma (Pomatocalpa* and *Trichoglottis),* Bl.
38. *Taeniophyllum,* Bl.

Eight species occur also in Australia. These are:—

1. *Didymoplexis pallens,* Griff.
2. *Goodyera viridiflora,* Bl.
3. *Pholidota imbricata,* Lindl.
4. *Oberonia iridifolia,* Lindl.
5. *Phaius grandifolius,* Lour.
6. *Microtis parviflora,* R. Br.
7. *Luisia teretifolia,* Gaud.
8. *Spiranthes australis,* Lindl. (=*S. sinensis,* Ames)

The first of these lists, as might have been expected, merely extends the range of the Papuan-Malay types, eliminating a few, such as *Zeuxine, Ornithochilus,* and *Osyricera.* It also eliminates a couple of Australian types, *Caladenia* and *Pterostylis.* It is likewise interesting to note the retention of two Australian genera, *Thelymitra* and *Microtis,* as well as the Australian section Dendrocoryne of the genus *Dendrobium,* together with the doubtfully Australian

(3) "Die Orchidaceen von Deutsch-Neu-Guinea" (1914), p. xviii.

(4) Ames, "Orchidaceae," v. (1915).

(5) Ames, "Orchidaceae," v. (1915), Pref., p. ix.

genus *Dipodium*. In this region the two great genera *Dendrobium* and *Bulbophyllum* still predominate with species greatly in excess of those in our own continent.

The Japanese botanist, B. Hayata,[6] who has recently devoted special attention to the botany of Formosa, enables us to carry our investigations a step further north. He has assigned 32 genera to the orchid-flora of that island. Of this number, 21 also occur in Australia, *viz.*:—

1. *Oberonia*, Lindl.
2. *Liparis*, L. C. Rich.
3. *Dendrobium*, Sw.
4. *Bulbophyllum*, Thou.
5. *Eria*, Lindl.
6. *Phreatia*, Lindl.
7. *Phaius*, Lour.
8. *Pholidota*, Lindl.
9. *Calanthe*, R. Br.
10. *Eulophia*, R. Br.
11. *Cymbidium*, Sw.
12. *Luisia*, Gaud.
13. *Cleisostoma*, Bl.
14. *Anoectochilus*, Bl.
15. *Zeuxine*, Lindl.
16. *Cheirostylis*, Bl.
17. *Goodyera*, R. Br.
18. *Cryptostylis*, R. Br.
19. *Nervilia*, Comm.
20. *Didymoplexis*, Griff.
21. *Habenaria*, Willd.

This table indicates a very considerable reduction in the number of genera in common with Australia, all of them being poorly developed in species and half of them monotypic. Almost without exception the species are endemic and there are none in common with our own.

Japan, lying in the North Pacific, between the 30th and 50th parallels of latitude, differs greatly in climate and humidity from the islands already considered.

Matsumura[7] in his Index records 71 genera of orchids, comprising 183 species. This, however, includes some Formosan plants. After deducting these, the flora stands at approximately 53 genera and 147 species. The following 23 genera are common to these islands and Australia:—

1. *Habenaria*, Willd. (5)[8]
2. *Microtis*, R. Br. (1)
3. *Galeola*, Lour. (2)
4. *Epipogum*, Gmel. (1)
5. *Nervilia*, Comm. (1)
6. *Gastrodia*, R. Br. (4)
7. *Spiranthes*, Rich. (1)
8. *Goodyera*, Bl. (9)
9. *Corymbis*, Thou. (1)
10. *Zeuxine*, Lindl. (1)
11. *Microstylis*, Nutt. (2)
12. *Oberonia*, Lindl. (1)
13. *Liparis*, Lour. (2)
14. *Phaius*, Lour. (2)
15. *Calanthe*, R. Br. (13
16. *Dendrobium*, Sw. (3)
17. *Bulbophyllum*, Thou. (2)
18. *Cirrhopetalum*, Lindl. (1)
19. *Eria*, Lindl. (2)
20. *Cymbidium*, Sw. (16)
21. *Sarochilus*, R. Br. (1)
22. *Luisia*, Gaud. (1)
23. *Taeniophyllum*, Bl. (1)

These genera are distributed throughout the parallels above mentioned, seven of them being recorded from the most northerly island of Yezo. Among the latter are such genera as *Gastrodia*, *Spiranthes*, *Calanthe*, and *Phajus*. As one might expect in these high latitudes, there is a great reduction in the development of *Eria*, *Dendrobium*, and *Bulbophyllum*, which are here represented by two, three, and two species, respectively. They do not appear to have been recorded so far north as the island of Yezo.

Only four orchids are conspecific with types in Australia, *viz.*:—*Corymbis (Corymborchis) veratrifolia*, Rchb. f.; *Spiranthes australis*, Lindl. (=*S. sinensis*, Ames); *Phajus grandifolius*, Lour.; *Microtis parviflora*, R. Br. The most

(6) Icones Plant. Formosan, iv. (1914), 23.

(7) J. Matsumura, "Index Plantarum Japonicorum," ii. (1905), 234.

(8) The number of species is included in brackets after the genus.

northerly range recorded for the Australian type *Microtis*, R. Br., is the island of Nippon, in latitude 36° N.

Turning now to the South Pacific Ocean, it at once becomes apparent that our material is much less extensive than that which we have been discussing, for a vast amount of work still remains to be accomplished in these regions. Practically the only islands from which we have fairly reliable (though often scanty) data, are:—New Caledonia (including the Loyalty Islands), New Hebrides, Fiji, Samoa, Society Islands (including Tahiti), the Solomons, the Carolines (including the Pelew Islands), the Marianne or Ladrone Islands, Bonin Island, and, of course, New Zealand, where excellent handbooks have been published.

In what follows, I have excluded the Bismarck Archipelago and that of D'Entrecasteaux, as forming part of New Guinea.

It appears from an investigation of our records, that less than a third of our exotic genera are unrepresented in this portion of the globe, though some of these may yet be reported. These genera comprise *Osyricera*, Bl.; *Pholidota*, Lindl.; *Pachystoma*, Bl.; *Epipogum*, Gmel.; *Phalaenopsis*, Lindl.; *Cleisostoma*, Bl.; *Ornithochilus*, Wall.; *Corymbis (Corymborchis)*, Thou.; *Cheirostylis*, Bl.; and *Apostasia*, Bl. The remaining genera are all represented by species which are almost exclusively endemic.

Four well-known genera are up to the present monotypic, viz., *Cymbidium*, Sw.; *Eulophia*, R. Br.; *Galeola*, Thou.; and *Vanda*, Jones. On the other hand, *Dendrobium* with upwards of 60 species, *Bulbophyllum* with about 23, *Phreatia* about 18, and *Calanthe* with 23, are well developed.

In one instance two islands a considerable distance apart, Samoa and Fiji, share a species of *Oberonia* in common. In another case, a species described by Reichb. f. as from the "Pacific Isles," is represented by a variety (9) in Thursday Island, a possession of Queensland. Two other well-known Australian species, *Dendrobium hispidum*, A. Rich., and *Calanthe veratrifolia*, R. Br., have been reported from Samoa and New Caledonia respectively. In addition to these, the widely distributed species *Phajus grandifolius*, Lour.; *Geodorum pictum*, Lindl.; *Luisia teretifolia*, Gaud.; and *Spiranthes australis*, Lindl. (=*S. sinensis*, Ames), also occur in Australia.

This last species, together with *Gastrodia sesamoides*, R. Br., and *Corysanthes bicalcarata*, R. Br.,(10) we also share with New Zealand.

Our exotic genera appear to be distributed among the above islands as follows:—

1.	New Caledonia	21	genera and	101	species
2.	Loyalty	2	„	2	„
3.	New Hebrides	4	„	11	„
4.	Fiji	13	„	33	„
5.	Samoa	18	„	54	„
6.	Society	10	„	16	„
7.	Tahiti	10	„	16	„
8.	Solomons	5	„	11	„
9.	Carolines	3	„	3	„
10.	Pelew Islands	2	„	2	„
11.	Marianne	3	„	3	„
12.	Bonin Island	1	„	2	„
13.	New Zealand	6	„	17	„
14.	Pacific Islands (unspecified) ..	10	„	18	„

(9) *Dendrobium Gouldii*, Richb. f., var. *acutum*, Richb. f.

(10) This species is conspecific with *C. Cheesemannii*, Hook. f., in the Dominion.

The following tables show the stations in the South Pacific for the various genera and the number of species representing each genus at the respective stations:—

1. *Microstylis*, Nutt. New Caledonia (1), Samoa (3), Fiji (8). Total 12 species, all endemic.
2. *Oberonia*, Lindl. New Caledonia (2), Samoa (2), Fiji (1), Loyalty (1), Society (2), Tahiti (1), Pacific Islands, unspecified, (2). Total 10 species, all endemic, except in the case of 1 species shared in common by Fiji and Samoa.
3. *Liparis*, Rich. New Caledonia (7), Samoa (4), Society (3), unspecified (1). Total 15, all endemic.
4. *Dendrobium*, Sw. New Caledonia (25), Samoa (7), Hebrides (7), Solomons (7), Fiji (7), Society (3), Pelew (2), Marianne (1), New Zealand (1), unspecified (5). Total 65, of which 63 are endemic.
5. *Bulbophyllum*, Thou. New Caledonia (12), Samoa (3), Fiji (1), Solomons (1), Carolines (1), Society (1), Pelew (1), New Zealand (2), unspecified (1). Total 23, all endemic.
6. *Cirrhopetalum*, Lindl. New Caledonia (2), unspecified (1). Total 3, endemic.
7. *Osyricera*, Bl. Unrepresented.
8. *Eria*, Lindl. New Caledonia (1), Samoa (5), Society (1), Solomons (1). Total 8, endemic.
9. *Phreatia*, Lindl. New Caledonia (9), Samoa (4), Fiji (2), Society (1), New Hebrides (1), Tahiti (1). Total 18, endemic.
10. *Pachystoma*, Bl. Unrepresented.
11. *Spathoglottis*, Bl. New Caledonia (6), Fiji and Samoa (1), Carolines (2), unspecified (1). Total 10, endemic.
12. *Phajus*, Lour. New Caledonia (4), Samoa (1). Total 5, of which 4 are endemic, and 1 from New Caledonia in common with Australia.
13. *Pholidota*, Lindl. Unrepresented.
14. *Calanthe*, R. Br. New Caledonia (7), Samoa (7), Fiji (3), Carolines (1), Tahiti (3), unspecified (2). Total 23, of which 22 are endemic, and 1 species common to New Caledonia and Australia.
15. *Eulophia*, R. Br. Loyalty Islands, 1 endemic.
16. *Cymbidium*, Sw. Solomons, 1 endemic.
17. *Geodorum*, Jacks. New Caledonia (1), Samoa (1), unspecified (1). Total 3, of which 2 are endemic; 1 (*G. pictum*, Lindl.) is common to New Caledonia and Australia.
18. *Luisia*, Gaud. New Caledonia (2), Bonin Island (2). Total 4, of which 3 are endemic, and 1 (*L. teretifolia*, Gaud.) from New Caledonia is in common with Australia.
19. *Phalaenopsis*, Lindl. Unrepresented in the South Sea Islands, but a species, *P. psilantha*, Schltr., occurs in the Celebes.
20. *Sarcochilus*, R. Br. New Caledonia (5), Fiji (1), Solomons (1), New Zealand (1). Total 8, endemic.
21. *Vanda*, Jones. Pacific Isles (unspecified), 1 endemic.
22. *Cleisostoma*, Bl. Unrepresented.
23. *Ornithochilus*, Wall. Unrepresented.
24. *Taeniophyllum*, Bl. New Caledonia (2), Samoa (1), Fiji (2), Society (1), Tahiti (2). Total 8, endemic.
25. *Galeola*, Thou. New Caledonia, 1 endemic.
26. *Corymbis (Corymborchis)*, Thou. Unrepresented.
27. *Spiranthes*, Rich. New Caledonia (2), New Zealand (1). Total 3, of which 1 species is endemic to New Caledonia, and 1 is common to the above stations and Australia.

28. *Anoectochilus*, Bl. New Caledonia (2), Fiji (1). Total 3, endemic.
29. *Zeuxine*, Lindl. New Caledonia (2), Samoa (4), Marianne Islands (1), unspecified (2). Total 9, endemic.
30. *Cheirostylis*, Bl. Unrepresented.
31. *Goodyera*, R. Br. New Caledonia (2), Samoa (1), New Hebrides (1), Tahiti (1). Total 5, endemic.
32. *Hetaeria*, Bl. Samoa (3), Fiji (3), Society (1). Total 7, endemic.
33. *Cryptostylis*, R. Br. New Caledonia (1), Samoa (1), Fiji (1). Total 3, endemic.
34. *Corysanthes*, R. Br. New Caledonia (1), Samoa (1), Hebrides (2), New Zealand (8), unspecified (1). Total 13, of which 12 are endemic, and 1 (*C. Cheesemanii*, Hook. f.) from New Zealand is conspecific with a species (*C. bicalcarata*, Br.) in Australia.
35. *Nervilia*, Comm. New Caledonia (1), Samoa (1), Marianne Islands (1). Total 3, endemic.
36. *Didymoplexis*, Griff. New Caledonia (1), Samoa (1). Total 2, endemic.
37. *Gastrodia*, R. Br. New Zealand 3, of which 2 are endemic and 1 (*G. sesamoides*, R. Br.) is common to New Zealand and Australia.
38. *Epipogum*, Gmel. Unrepresented.
39. *Habenaria*, Willd. New Caledonia (2), Fiji (2), Samoa (4), Society (2). Total 10, endemic.
40. *Dipodium*, R. Br. New Caledonia (1), Hebrides (1). Total 2, endemic.
41. *Apostasia*, Bl. Unrepresented.

Of all our exotic genera, *Dendrobium* aand *Bulbophyllum* are probably the most interesting, having a vast developing centre and distributing depôt in New Guinea, adapting themselves to great extremes of climate, and extending in their range from 37° of latitude north to well below 47th parallel of latitude south (Stewart Island).

To Australians, particular interest will centre round another genus, *Corysanthes*, R. Br., which we have hitherto considered a true Australian type. Until recently, it was known to the botanical world by less than a dozen species scattered over our Commonwealth and New Zealand, together with four presumable emigrants resident in Java. To-day we must readjust our views. Close on 50 species are now known, with apparently a propagating centre in New Guinea from which station 21 species have already been described. It has also been reported from the Himalayas, from several islands in the Malay Archipelago, from the Celebes, the Philippines, and three from the South Sea Islands. The range of these delicate little plants is thus seen to be great, extending from a little below the Tropic of Cancer to Stewart Island (New Zealand), situated about the 47th parallel of south latitude. Of the 8 species which are natives of New Zealand, only one is conspecific with a species in Australia. A characteristic feature of the endemic species of the Dominion is to be found in the long filiform lateral sepals and petals. This is not present in any known Australian species, but is seen in two of the Javanese species, and also in some of those recorded by Schlechter, J. J. Smith, and Ridley, from New Guinea. It is curious that the development of this genus should be greater within the narrow confines of New Zealand than on our own continent.

Another exotic of more than passing interest to our botanists is *Cryptostylis*, R. Br. It is distributed from Ceylon, through the Malay Archipelago to New Guinea, where it reaches its maximum development. Hayata [11] reports a species

[11] "Icones. Plant. Formosan.," iv. (1914), 117.

from Formosa,[12] and Ames[13] records the Javanese species *(C. arachnites*, Bl.) from the Philippines; 3 endemic species also occur in different islands in the South Pacific. Altogether some 17 species have been described. Schlechter[14] speaks of these plants in New Guinea as typical mountain-climbers, as they have been collected at considerable heights. This has also been our experience in Australia, and Baron von Mueller[15] has likewise described a member of this genus from Samoa, where it was found growing at an altitude of 3,000 feet (upwards of 900 metres).

Dipodium, R. Br., has also been placed among the exotic genera, although it is admittedly difficult to decide on the immigrant nature of this genus, as it occurs sporadically in the Malay Archipelago, New Guinea, Celebes, New Caledonia, and New Hebrides. The fact that some of its members are epiphytic and others terrestrial saprophytes, appears to indicate its affinities with a tropical flora. Including our own two species, 11 have been described. Further knowledge of the orchid vegetation of New Guinea may dispel any doubts as to the position of this particular genus.

3. Australian Types, not Endemic.

The following are regarded as true generic types originating in Australia, but not endemic:—

1. *Calochilus*, R. Br.
2. *Thelymitra*, Forst.
3. *Orthoceras*, R. Br.
4. *Prasophyllum*, R. Br.
5. *Microtis*, R. Br.
6. *Pterostylis*, R. Br.
7. *Caleana*, R. Br.
8. *Acianthus*, R. Br.
9. *Lyperanthus*, R. Br.
10. *Cyrtostylis*, R. Br.
11. *Caladenia*, R. Br
12. *Adenochilus*, Hook. f.
13. *Chiloglottis*, R. Br.

The distribution of these genera is as follows:—

1. *Calochilus*, R. Br. Australia 5, New Zealand 2 (in common with Australia), New Caledonia 1. Total species 6, of which 4 are endemic.
2. *Thelymitra*, R. Br. Australia 30, New Zealand 12 (5 in common with Australia and 7 endemic), New Caledonia 2 (1 endemic, 1 in common with Australia), Java 1 (in common with Philippines), Timor 1 (endemic). Total 40, of which 34 are endemic.
3. *Orthoceras*, R. Br. Australia 1, New Zealand 1 (in common with Australia). Total 1.
4. *Prasophyllum*, R. Br. Australia 58, New Zealand 4 (of which 2 are in common with Australia), New Caledonia 1 (doubtful). Total 60, of which 58 are endemic.
5. *Microtis*, R. Br. Australia 9, New Zealand 1 (in common with Australia), New Caledonia 2 (of which 1 is endemic and 1 in common with Australia), 1 Australian species reported from Java, Formosa, Philippines, Japan, and South China. Total 10, of which 8 are endemic.
6. *Pterostylis*, R. Br. Australia 43, New Zealand 12 (of which 8 are endemic and 4 common to Australia), New Caledonia 4[16] (of which 1 is endemic and 3 in common with Australia), New Guinea 2 (endemic). Total 54, of which 50 are endemic.

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(12) A species which appears to be identical with that of Hayata is reported by Rogers and White from British New Guinea in Trans. Roy. Soc. S. Austr., xliv. (1920), p. 118.

(13) "Orchidaceae," v. (1915), 19.

(14) "Die Orchidaceen von Deutsch-Neu-Guinea" (1914), 26.

(15) Wing's Southern Sc. Rec., i. (1881), 172.

(16) Rendle, Journ. Linn. Soc., xlv. (1921), 253.

7. *Caleana*, R. Br. Australia 4, New Zealand 1 (in common with Australia). Total 4, 3 of which are endemic.
8. *Acianthus*, R. Br. Australia 5 (endemic), New Zealand 1 (endemic), New Caledonia 12 (endemic).[17] Total 18, endemic.
9. *Lyperanthus*, R. Br. Australia 5 (endemic), New Zealand 1 (endemic), New Caledonia 7 (endemic). Total 13, endemic.
10. *Cyrtostylis*, R. Br. Australia 1 (endemic), New Zealand 1 (endemic). Total, 2, endemic.
11. *Caladenia*, R. Br. Australia 56, New Zealand 4 (endemic), New Caledonia 1 (in common with Australia), Java 1 (in common with Australia), Timor 1 (doubtful). Total 60 or 61, of which 58 are endemic to Australia.
12. *Adenochilus*, Hook. f. Australia 1 (endemic), New Zealand 1 (endemic). Total 2, endemic.
13. *Chiloglottis*, R. Br. Australia 7, New Zealand 2 (of which 1 is endemic and 1 common with Australia). Total 8, of which 7 are endemic.

It is important to notice that the closest affinity of Australia's typical genera is clearly with New Zealand, where all are represented, and no less than 9 of them by one or more species common to the two countries, the remaining 4 being represented by species endemic to New Zealand. *Thelymitra* and *Pterostylis* have undergone considerable development in the Dominion, each of them comprising 12 species.

It is significant also, that from only one other station in the South-east Pacific, have any of our typical genera been reported, *viz.*, New Caledonia, where 7 of these emigrants have become resident. Out of this number four are represented by species in common with this country, *viz.*, *Thelymitra, Microtis, Pterostylis, and Caladenia*, and the others by a considerable number of endemic forms, *Acianthus* comprising 12, and *Lyperanthus* 7.

It may seem rather remarkable that New Caledonia, which, according to the present disposition of land areas, is only about 700 miles distant from the nearest coastline of the Commonwealth, should contain relatively such a smaller proportion of our orchid-flora than New Zealand, which is further removed. It must be remembered, however, that apart from the difference in superficial area of the two places, the botany of the former island has been much less thoroughly investigated than that of the other; and further, that the genera under consideration are much more generously developed in the south-eastern portion of Australia than in Queensland.

Three of the above types—*Thelymitra, Microtis,* and *Caladenia*—have reached the Malay Archipelago, where they are represented monotypically, one by an endemic and the other two of them by Australian species.

So far, only one genus, *Pterostylis,* has been reported from New Guinea, but it is by no means improbable that others will be discovered soon. Both of these were collected at great altitudes.

Only two genera appear to have migrated to any considerable distance from their native habitat, *viz.*, *Thelymitra* and *Microtis*. Both of these have been recorded from the Philippines by Ames,[18] the former being represented by a Javanese species, and the latter by a plant supposed to be conspecific with *Microtis porrifola,* Spreng., and identical with the Javanese *Microtis*. The

(17) Rendle, *l.c.*, 254.

(18) "Orchidaceae," v. (1915), 18.

latter, however, as illustrated by J. J. Smith,[19] is almost certainly *M. parviflora*, R. Br., and not *M. porrifolia*, Spreng. If this is correct, *M. parviflora* has an enormous range, extending from Japan, where it has been reported by Matsumura,[20] through the Philippines, South China, Java, New Caledonia, and Tasmania. The genus itself extends as far south as Stewart Island (New Zealand) in latitude 47°.

The internal distribution of these genera throughout the States is shown below, along with the rest of the orchid-flora. It is probably sufficient to state here, that it is essentially extra-tropical and but poorly developed in Queensland and Northern Territory. Three of the genera—*Adenochilus, Orthoceras,* and *Cyrtostylis*—are monotypic. The first of these is extremely localized and confined to New South Wales. *Cyrtostylis* occurs within the orchid zones in all States, and *Orthoceras* has been reported from the southern border of Queensland and from all other States except Western Australia.

The most important of them are *Thelymitra, Prasophyllum, Pterostylis,* and *Caladenia.* The first of these finds its maximum development in Western Australia with 17 species; the next in New South Wales with 23; *Pterostylis* in New South Wales and Victoria, each with 27; and *Caladenia* in Western Australia, with 35.

Calcana is a small genius of four species. Three of these are confined to Eastern and South Australia; the fourth is peculiar to Western Australia.

Acianthus is also a small genus with five species. It is distributed along the coast of Eastern and South Australia, becoming reduced to a single species in the West, where it is rare and localized.

Lyperanthus comprises five species, only one of which occurs in Queensland and South Australia. Three are known in New South Wales, one of which is peculiar to that State; three also in Western Australia, one of these being limited to that part of the continent; two occur in Victoria and Tasmania.

Chiloglottis has seven species, all of which are restricted to the east coast of the continent and Tasmania.

4. Endemic Flora.

Australia possesses nine (possibly 10) endemic genera:—

1. *Adelopetalum*, Fitzg. (?)
2. *Epiblema*, R. Br.
3. *Diuris*, Sm.
4. *Anticheirostylis*, Fitzg.
5. *Drakaea*, Lindl.
6. *Spiculaea*, Lindl.
7. *Eriochilus*, R. Br.
8. *Burnettia*, Lindl.
9. *Leptoceras*, Lindl.
10. *Glossodia*, R. Br.

Adelopetalum, Fitzg., is not admitted by all botanists to separate generic rank. The founder described and figured it as apetalous. He further regarded it as identical with a Queensland plant described by F. M. Bailey[21] under the name of *Bulbophyllum bracteatum*. In the latter plant, the petals are developed, as I have personally observed by an examination of fresh specimens sent to me from Queensland. These segments are hidden by the dorsal sepal and may possibly have escaped the notice of Fitzgerald. If the two plants are really identical as they appear to be, one would have no hesitation in regarding it as an aberrant form of *Bulbophyllum*. Fitzgerald's plant was found in the extreme north of New South Wales close to the Queensland border, and Bailey's on the Nerang River in the south of the latter State.

(19) "Die Orchideen von Java," Atlas, i., 1908), t. 26.
(20) Index Plant. Japon., ii. (1905), 254.
(21) Bot. Bull., iv. (1891), 17.

Of the other genera, four are monotypic, *viz.*, *Epiblema*, a close relation of *Thelymitra*, and confined to the extreme south-western portion of Western Australia; *Auticheirostylis*, described by R. D. Fitzgerald from a single locality in New South Wales; *Burnettia*, related to *Lyperanthus* and limited in its distribution to the three States of New South Wales, Victoria, and Tasmania; and *Leptoceras*, a genus without any very close affinities, but approaching most nearly to *Eriochilus* and a single member *(C. Mensiesii*, Br.) of the Caladenias. *Leptoceras* has undoubtedly reached us from Western Australia, where it is very common. It is distributed sparsely in South Australia, is rare in Victoria, and has not been recorded from any of the other States.

By far the best developed of the endemic genera is *Diuris*, comprising 25 species, well represented in all the States of extra-tropical Australia, and in one instance penetrating into the tropics as far north as the 18th parallel of latitude. Some of its members are adapted to very variable conditions of soil and climate, one having been recorded even from the great Victoria Desert in the West It hybridizes easily and propagates freely, both by cross-pollination and by the vegetative method. It is singular that a genus having such admirable properties for dispersion should not have been reported from any station outside Australia. Its gynostemium approaches rather nearly in its fundamental structure to that of *Thelymitra*, and the only apparent advantage possessed by the latter genus is that it includes among its members some self-pollinating species, while *Diuris* has none. Yet *Thelymitra* has migrated as far into the tropics as the Malay Archipelago and the Philippines, and certain of its Australian self-pollinating species are to be found in New Zealand and New Caledonia. *Diuris* is an exceedingly characteristic and virile genus and finds its best development in New South Wales, where it is represented by 17 species.

Drakaea and *Spiculoea* are two very remarkable small genera with grotesque insectiform flowers. Lindley very properly separated them, but Bentham combined them, although they had very few characters in common Quite recently Schlechter[(22)] has proposed that Lindley's separation into two genera be again restored. Each genus now contains three species, all the *Drakaeas* and one species of *Spiculoea* being peculiar to Western Australia, and two species of *Spiculoea* being confined to the Eastern States of Queensland, New South Wales, and Victoria. *Spiculoea irritabilis* penetrates the tropics as far as the 18th degree of south latitude.

Eriochilus is monotypic in the five Eastern States, but in the Western is represented by four other species, which are peculiar to the south-western corner of the continent. This genus is probably most nearly allied to *Caladenia*.

Glossodia contains five species, two of which occur in Queensland, New South Wales, and Victoria, and one of these in Tasmania and South Australia; as in the case of *Eriochilus*, the remaining three are peculiar to the south-western corner of the continent. It is extra-tropical.

An examination of our endemic orchid-flora shows that a number of them are peculiar to various States. It will be noticed that the number of species comprised under the above nine genera is 45. Of these no less than two genera and 18 species are peculiar to Western Australia. These will, in all probability, be considerably augmented as our knowledge of the flora of that part of the continent increases.

In New South Wales one of the endemic genera is peculiar to that State, and also nine species.

In South Australia only one species of an endemic genus is peculiar, and in the remaining States there are not any.

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(22) Fedde, Repert., xvii. (1921), 78.

5. General.

The distribution of the various genera throughout the States of the Commonwealth is shown in the following table, the endemic genera being indicated by an asterisk:—

Genera	No of valid Species						
	N. Ter.	Qd.	N S W	Vict.	Tas.	S.A.	W.A.
1. *Microstylis*, Nutt.		1					
2. *Oberonia*, Lindl.		2	2				
3. *Liparis*, Rich.		8	2				
4. *Dendrobium*, Sw.	3	44	14	2	1		1
5. *Bulbophyllum*, Thou.		16	5				
6. **Adelopetalum*, Fitz.			1				
7. *Cirrhopetalum*, Lindl. ..		1					
8. *Osyricera*, Bl.		1					
9. *Eria*, Lindl.		3					
10. *Phreatia*, Lindl.		2					
11. *Pachystoma*, Bl.	1						
12. *Spathoglottis*, Bl.		2					
13. *Phaius*, Lour.		2	1				
14. *Pholidota*, Lindl.		1					
15. *Calanthe*, R. Br.		1	1				
16. *Eulophia*, R. Br.	1	2					1
17. *Cymbidium*, Sw.	1	5	3				1
18. *Geodorum*, Jacks.	1	2	1				
19. *Dipodium*, R. Br.	1	2	1	1	1	1	
20. *Luisia*, Gaud.		1					
21. *Phalaenopsis*, Lindl.		1					
22. *Sarochilus*, R. Br.		15	8	2	1		
23. *Vanda*, R. Br.	1						
24. *Cleisostoma*, Bl.		7	2				
25. *Ornithochilus*, Wall. .. .		1	1				
26. *Taeniophyllum*, Bl.		1	1				
27. *Galeola*, Thou.		2	2				
28. *Corymbis*, Thou.		1					
29. *Spiranthes*, Rich.		1	1	1	1	1	
30. *Anoectochilus*, Bl.		1					
31. *Zeuxine*, Lindl.		2					
32. *Cheirostylis*, Bl.			1				
33. *Goodyera*, R. Br.		2					
34. *Hetaeria*, Bl.		1					
35. *Thelymitra*, Forst.		2	10	15	8	16	17
36. **Epiblema*, R. Br.							1
37. **Diuris*, Sm.		9	17	8	5	8	7
38. *Orthoceras*, R. Br.		1	1	1	1	1	
39. *Cryptostylis*, R. Br.		2	3	2	1	1	1
40. *Prasophyllum*, R. Br		7	23	20	12	13	15
41. **Anticheirostylis*, Fitzg. ..			1				
42. *Microtis*, R. Br.		2	2	3	3	4	8

*Endemic genera.

Genera	No. of valid Species.						
	N. Ter.	Qd.	N.S.W.	Vict.	Tas.	S.A.	W.A.
43. *Corysanthes*, R. Br.		3	4	4	4	3	1
44. *Pterostylis*, R. Br.	1	16	27	27	17	21	10
45. *Caleana*, R. Br.		2	2	3	2	2	1
46. **Drakaea*, Lindl.							3
47. **Spiculoea*, Lindl.		1	2	2			1
48. *Acianthus*, R. Br.		3	3	2	3	2	1
49. **Eriochilus*, R. Br.		1	1	1	1	1	4
50. *Lyperanthus*, R. Br.		1	3	2	2	1	3
51. **Burnettia*, Lindl.			1	1	1		
52. *Cyrtostylis*, R. Br.		1	1	1	1	1	1
53. **Leptoceras*, Lindl.				1		1	1
54. *Caladenia*, R. Br.		5	16	19	12	18	35
55. **Glossodia*, R. Br.		2	2	2	1	1	3
56. *Adenochilus*, Hook. f. ..			1				
57. *Chiloglottis*, R. Br.		2	5	5	2		
58. *Calochilus*, R. Br.	1	2	3	4	1	2	1
59. *Nervilia*, Comm.	1	4					
60. *Didymoplexis*, Griff.	1						
61. *Gastrodia*, R. Br.		2	1	1	1		1
62. *Epipogum*, Gmel.		1	1				
63. *Habenaria*, Willd.	9	8					
64. *Apostasia*, Bl		1					
Total number of valid species for each State	22	209	177	130	82	98	118
Total number of genera for each State	12	53	40	25	23	19	23

*Endemic genera.

CONTRIBUTIONS TO THE ORCHIDACEOUS FLORA OF AUSTRALIA.

By R. S. Rogers, M.A., M.D.

[Read October 11, 1923.]

Plate XXVII.

Caladenia cristata, n. sp.

Planta gracilis, hirsuta, circa 30 cm. alta; folium lineare, circiter 10 cm. longum, hirsutissimum; bractea subulata ad medium caulis. Flos solitarius. Sepala subaequalia, circiter 2 cm. longa; dorsale lanceolatum, erectum, incurvatum; lateralia latiora, acuminata, patentia. Petala circiter 15 mm. longa, sepalis angustiora. Labellum breviter unguiculatum, mobile, cordiforme, apice recurvo, circiter 8 mm. longum, marginibus integerrimis; calli stipitati, atropurpurei, clavati vel lineares, confertissimi, in lamina forma cristae mediae instructi, prope apicem terminantes. Columna subaequilonga labello, incurvatissima, in dimidio superiore late membranaceo-dilatata.

Western Australia: Murchison District, Dr. E. S. Simpson, September, 1923.

A slender hairy plant about 30 cm. high; leaf linear about 10 cm. long; a subulate appressed stem-bract about the middle and a shorter acuminate bract below the flower pedicel. Flower solitary; segments of perianth yellowish-green, with a central reddish stripe; sepals subequal, the dorsal one erect incurved lanceolate about 2 cm. long, the lateral ones wider acuminate spreading; the lateral petals linear-lanceolate, much narrower than the sepals, about 1 5 cm. long. Labellum reddish-brown, spreading, mobile on a short claw, cordiform, the extreme apex shortly recurved, margins entire; lamina with divergent red veinings; calli on long ciliated stalks, crowded into a conspicuous rather narrow dense crest along the centre, extending from the claw almost to the apex, the extremities purple bilobed near the claw clavate towards the centre of the disc and more or less linear near the apex. Column almost equal in length to the labellum, much incurved and very widely winged in its upper half.

This very striking and characteristic species approximates in the shape of its column and in the arrangement of its calli to *Caladenia plicata*, Fitzg., but differs from that species in the absence of clubbed sepals and fringed labellar margins. In my specimens the margins of the labellum are revolute, possibly due to deterioration of the flower during the journey. The calli do not appear to be arranged in definite rows as in *C. plicata*, but are crowded into a dense dark purple central band, which stands conspicuously erect on the lighter-coloured disc. The specific name has reference to the crested appearance of this band of calli.

I am indebted for my specimens to Mrs. Pelloe, the well-known flower artist of Perth.

Prasophyllum Colemanae, n. sp.

Planta robustiuscula, 30-40 cm. alta; spica circiter 8 cm. longa, laxiuscula. Flores lavandulacei vel lilacini, circiter 21, pedicellis perbrevibus; ovaria brevia turgida. Sepalum dorsale subviride, circiter 7 mm. longum, oblongo-lanceolatum, concavum, erectum vel recurvum, apice acuto; lateralia viridia, libera, divaricata, patentia, circiter 8 mm. longa. Petala lavandulacea, obtusiusculis apicibus, patentia, 7 mm. longa, 1·75 mm. lata. Labellum lavandulaceum, subaequilongum sepalis lateralibus, late ovatum, subsessile, complanatum, in medio leviter recurvum, marginibus crenatis ad apicem; pars callosa tenuis, subviridis, paulum ultra flexum producta; pars membranacea perlata. Columna brevis, laciniis oblongo-falcatis obtusibus rostello brevioribus; caudicula longuiscula.

Victoria: Bayswater, Mrs. Edith Coleman, 12/11/22.

A moderately stout species with a rather loose spike of about 21 lavender (or lilac) flowers. Each flower subtended by a short wide rather blunt appressed bract, pedicel very short; ovaries short and turgid, not markedly retracted from the floral axis. Dorsal sepal greenish, about 7 mm. long, oblong-concave in its lower two-thirds, contracted above this into a somewhat conical point, recurved or erect; lateral sepals green, stout, conical, fluted above, spreading, about 8 mm. long, very divergent. Petals lavender with narrow green central stripe; 7 5 mm. long, 1 75 mm. in widest part, narrowly oblong, rather blunt, spreading. Labellum lavender, nearly as long as the lateral sepals, widely ovate, nearly sessile; upper surface rather flat; slightly flexed in the middle; margins crenated anteriorly; the callous disc thin, greenish, ending in two inconspicuous knuckles just beyond the bend; the membranous part very wide; tip rather blunt. Column short; lateral appendages oblong-falcate with blunt often truncate tips and small basal lobes, shorter than the rostellum, usually lavender tinted, adnate to the sides of the stigmatic-plate as high as the base of the stigma; anther purplish, shorter than the lateral appendages and much shorter than the rostellum; caudicle rather long.

Named in honour of Mrs. Coleman and her daughters, enthusiastic collectors of orchids in Victoria.

Prasophyllum Tadgellianum, n. sp.

Planta robustiuscula, 15-23 cm. alta; folium spicam excedens; spica laxa, 4-5 cm. longa. Flores fere 8-12, pedicellis brevibus, subvirides, interdum cum notationibus bruneis. Sepalum dorsale late lanceolatum, subconcavum, acuminatum, circiter 6 mm., basi contractum; lateralia usque ad medium connata, circiter 5 mm. longa. Petala falco-lanceolata, subpatentia, circiter 5 mm. longa. Labellum sessile, inferiore dimidio ad columnam erectum, deinde in semicirculo recurvum, a basi suborbiculare, ultra flexum anguste cuneatum; pars callosa triangularis, paene ad apicem prominente producta. Columnae laciniae in altitudine rostello aequantes, falcatae, obtusae. Stigma oblique reniforme. Anthera rostello paulo brevior.

Victoria: Mount Bogong (6,500 feet), A. J. Tadgell, 7/2/23; Mount Hotham (5,100 feet), Dec., 1914.

New South Wales: Mount Kosciusko, Dr. Green, Dec., 1921.

Plant rather short and stout, from about 15-23 cm. high; the leaf exceeding the spike in length. Spike loose, 4-5 cm. long. Flowers usually 8-12, on short pedicels, greenish, or yellow with chocolate markings down the middle of the perianth-segments, also down the middle and on the sides of the labellum. Dorsal sepal widely lanceolate, somewhat concave, acuminate, contracted at the base, about 5 mm. long; lateral sepals connate to the middle, about 5 mm. long. Labellum sessile, the lower half almost orbicular erect against the column, then semicircularly recurved, narrowly cuneate beyond the bend; callous part rather widely triangular at the base, prominently raised and extending almost to the tip of the distal half; membranous part rather narrow throughout. Wings of the column about equal in height with the rostellum, falcate with truncate or obtuse tips. Stigma very oblique, reniform. Anther slightly shorter than the rostellum.

This plant was described by me as a variety of *Prasophyllum Frenchii*, F. v. M., in Transactions of the Royal Society of South Australia, xlvi. (1922), page 153. Fresh material has led me to believe that it should be regarded as a new species. It is a less slender and stouter plant than *P. Frenchii*, the labellum is not laterally contracted as in that species, and the lateral sepals in all my specimens were definitely and consistently connate.

It has only reached me from alpine stations. Mr. Tadgell states: "Mostly they grow in exposed positions, nearly to the height of the cairn (6,508 feet) in

the grass or at the edges of damp watercourses. None were collected lower than 5,750 feet. Their life (season) is short; in a fortnight they seem to mature and go off."

Microtis oblonga, n. sp.

Planta gracillima, circa 22-45 cm. alta; folium elongatum, gracile, lamina circa 22 cm. longa. Spica laxa, fere circa 20 cm. longa. Flores minutissimi, dissitissimi, pedicellis brevibus gracilibus; ovaria gracilia oblongo-elliptica. Sepalum dorsale circa 3 mm. longum, suberectum, anguste cucullatum, acutum, apice leviter recurvo; lateralia arte revoluta. Petala circa 2 mm. longa, erecta, obtusa vel truncata, lineari-falcata, subconniventia cum sepalo dorsali. Labellum circa 2·5 mm. longum, reflexum, anguste oblongum, marginibus crenulatis, basi bicallosum prope apicem unicallosum. Columna robusta, brevissima, auriculis comparate grandibus.

Victoria: Cravensville, A. B. Braine; Ringwood, E. E. Pescott and A. B. Braine; Healesville, Edith Coleman; Grampians, C. W. D'Alton.

South Australia: Myponga, Rogers.

A very slender plant, about 22-45 cm. high; leaf slender, often exceeding the spike. Spike lax, generally 15-22 cm. long. Flowers very small, very distant, on short slender pedicels; ovaries slender, oblong-elliptical. Dorsal sepal about 3 mm. long, almost erect, narrowly hooded, acute, the apex slightly recurved; lateral sepals tightly revolute. Lateral petals about 2 mm. long, erect, obtuse or truncate, linear-falcate, posterior margins overlapped by dorsal sepal Labellum about 2·5 mm. long, reflexed, narrowly oblong, the margins crenulated, two large callosities at the base and one near the apex. Column stout, very short, with relatively large auricles. Caudicle long, pollinarium easily removed on a needle.

This species is by no means uncommon in Victoria and South Australia, and has hitherto been confused with *M. parviflora*, Br., and sometimes with *M. porrifolia*, Spreng. The former has a labellum with entire margins which are not crenulated and there is no anterior callus. The latter is a robust plant with a very much larger flower than the new species, with a very wide dorsal sepal, deeply emarginate labellum, and very turgid ovary; it should be easily distinguished. *M. oblonga* approaches rather closely to *M. truncata*, Rogers, a Western Australian species. In the latter, however, the labellum is at least as long as the dorsal sepal, the ovary is much twisted, and the calli on the labellum assume curious shapes, hastate or crescentric, whereas in the former they are rounded.

The labellum is occasionally very slightly notched at the apex, and in dried specimens, owing to shrinkage, it often shows a marked lateral contraction, a feature which is seldom marked in the living specimen. It blooms in November and December.

Pterostylis decurva, n. sp.

Glabra, gracillima, circa 10-20 cm. alta. Folia radicalia fere 3, ovata vel ovalia, petiolis gracillimis sublongis; caulina bracteata, 4-5, sessilia, lineari-lanceolata, acuminata, circa 0·5-2·5 cm. longa. Flos solitarius, viridis, subgrandis. Galea apice filiformi decurvissimo instructa. Labium inferius erectum, cuneatum, sinu latissimo; lobi saepe 4-5 cm. longi, apicibus filiformibus instructi. Labellum unquiculatum, lineari-oblongum, apice obtusum; lamina circiter 11 cm. longa, linea longitudinalis elevata in medio; appendix trifida, curvata, penicillata. Columna circiter 11 cm. longa, erecta; lobi superiores laciniarum lineares acuti, inferiores oblongi, obtusi. Stigma ellipticum in medio columnae.

Victoria: Fern-tree Gully, E. E. Pescott and A. N. Burns, 20/11/20; also Ringwood and Belgrave, E. E. Pescott.

A very slender glabrous species about 10-20 cm. high. Radical leaves not present at the time of flowering, usually 3, ovate or oval, on rather long and

very slender petioles; stem-leaves bract-like, 4-5, sessile, acuminate, linear-lanceolate, from 0 5-2 5 cm. long. Flower solitary, green with reddish-brown apex of galea and tip of labellum, often 4 cm. between the extreme points. Galea extended at the apex into a long filiform and very much decurved point. Lower lip erect, cuneate, with a very wide sinus, its lobes often 4-5 cm. long, prolonged on each side of the galea into long filiform points. Labellum on an irritable claw about 2 mm. long, linear-oblong, very obtuse at the apex, the latter recurved and protruding from the sinus; lamina about 11 cm. long, with a raised longitudinal line down the middle; appendix trifid, curved, penicillate. Column about 11 mm. long, erect; the upper angles of the wings produced into an acute linear tooth; the lower ones obtusely oblong. Stigma elliptical in the centre of the column.

The new species undoubtedly comes very close to *Pterostylis obtusa*, Br., but it blooms at a totally different period of the year in exactly the same locality, and in the living plant it differs strikingly in the extreme decurvature of the apex of the galea, a characteristic feature which is often lost in the process of drying and pressing.

Descriptions of the following orchids were published in English in Transactions Royal Society South Australia, xliv. (1920), page 322, *et seq.* They now appear in Latin in order to comply with the requirements of the Vienna Congress:—

Drakaea Jeanensis, n. sp.

Gracillima, circiter 18-24 cm. alta. Folium orbiculare vel late ovato-cordatum, circiter 2 5 cm. in diametro, subrigidum, glabrum. Flos solitarius; ovarium subpyramidale. Segmenta perianthii subaequalia, anguste linearia, circiter 12 mm. longa; sepalum dorsale retroflexum; lateralia acute deflexa; petala acute deflexa, apicibus decussatis. Labellum insectiforme, mobillimum, ad apicem pedis columnae per unguem elongatum linearem articulatum; lamina circiter 12 mm. longa peltata, in duo lobis inaequalibus per constrictionem villosissimam divisa; lobus minor globosus, tuberculatissimus, hirsutissimus; lobus major substrictus convexus, prope unguem leviter pilosus, alibi levis, ad apicem subovatus, marginibus subrevolutis. Columna gracillima, retroflexa, ad apicem incurva, circiter 9 mm. longa, basi in pedem elongatum linearem producta, ad basin 2-auriculis parvis triangularibus. Anthera magna obtusa; rostellum non prolongum.

Western Australia: Ravenswood, near Pinjarra, Jean Scott Rogers, 1/10/19.

Microtis truncata, n. sp.

Gracillima, circiter 22-38 cm. alta. Folium anguste lineare; fistula infra medium; lamina circiter 10-25 cm. longa. Spica circiter 12-25 cm. longa; flores subvirides dissiti, pedicellis brevibus. Sepalum dorsale ovatum, cucullatum, erectum, apice acuto leviter recurvo, circiter 3 75 mm. longum 2 5 latumque; lateralia arte revoluta, oblongo-lanceolata, circiter 2 5 mm. longa. Petala erecta, obtusa, lineari-falcata, circiter 2 75 mm. longa, sepalis angustiora. Labellum paene oblongum, in medio contractum, marginibus leviter crenulatis, circiter 3 75 mm. longum, ·5-nervosum; basi duo callis oblongo-ovalibus vel lunatis, anteriore unico callo magno hastato incrassatum. Columna brevissima; anthera minute mucronata, auriculis grandibus prominentibus.

Western Australia: Diamond Tree School, near Jarnadup, Miss Ilma Knox-Peden, December, 1918.

Prasophyllum lanceolatum, n. sp.

Subgracilis, circiter 40-77 cm. alta. Lamina folii circiter 12-15 cm. longa, spicam non excedens. Spica circiter 12-21 cm. longa; flores sub-brunnei, dissiti, ovaria brevia gracilia. Segmenta perianthii anguste lanceolata; sepalum dorsale

leviter incurvum, circiter 10 mm. longum 2 mm. latumque, 5-nervosum, acuminatissimum; lateralia in medio connata, circiter 8 5 mm. longa. Petala angusta, falco-lanceolata, 5-nervosa, circiter 7 mm. longa 1 25 mm. lataque. Labellum lanceolatum, perbreve unguiculatum, circiter 6 5 mm. longum, prope medium arcuatum; pars membranacea angusta, marginibus integerrimis non crenulatis; pars callosa comparate grandis, lanceolata, non crassa, circiter 5 mm. longa, paene ad apicem producta, marginibus liberis. Columnae laciniae in altitudine rostello et antherae aequantes, lineari-falcatae, obtusae, membranaceae, inaequaliter bidentatae. Caudicula sub-brevis; glandula grandis, ovato-lanceolata.

Western Australia: Albany, Dr. A. Syme Johnson; Muresk, Mrs. W. E. Cooke, 4/9/07.

Prasophyllum ellipticum, n. sp.

Planta robusta, ad 104 cm. alta. Lamina folii ad 65 cm longa, spicam non excedens. Spica circiter 28 cm. longa. Flores sessiles, subvirides, numerosi, conferti; ovaria gracilia, circiter 12 mm. longa. Segmenta perianthii angustiuscula; sepalum dorsale angustum, ovato-lanceolatum, 7-nervosum, sepalis lateralibus longiore, fere erectum, leviter incurvum, circiter 12 5 mm. longum 4 mm. latumque; lateralia in medio connata, circiter 11 mm. longa. Petala obtuse falcata vel falco-lanceolata, erecta, 5-7 nervosa, circiter 9 5 mm. longa 2 5 mm. lataque. Labellum perbreviter unguiculatum, ellipticum, circiter 11 mm. longum 5 25 mm. latumque, ad apicem gradatim recurvum; pars membranacea alba, lata, ample crispata; lamella adnata tenuis, circiter 6 5 mm. longa 4 5 mm. lataque, marginibus lateralibus liberis, ultra flexum in angustiusculo obtuso cacumine terminans. Columnae laciniae membranaceae, obtuse falcatae, rostello longiores, circiter 5 mm. altae, basi lobulatae. Anthera apiculata, rostello brevior.

Western Australia: Near Jarnadup, Ilma Knox-Peden, 21/12/18.

Caladenia pectinata, n. sp.

Planta robusta, saepe 60 cm. alta. Caulis hirsutus, unibracteatus. Folium anguste lineare, hirsutissimum. Flos circiter 6-9 cm. in diametro, fere solitarius, subflavus cum notationibus subrufis. Sepalum dorsale erectum, leviter incurvum, ad basin dilatatum concavum, longissime caudatum, clavatum, circiter 5 cm. longum; lateralia sepalo dorsali similia, patentia. Petala retroflexa, anguste lanceolata, acuminata, non clavata, sepalis angustiora, circiter 3 5 cm. longa. Labellum breviter unguiculatum, ovato-oblongum vel late ovato-lanceolatum, circiter 2 cm. longum, obscure 3-lobatum; dimidium inferius ad columnam erectum, marginibus profunde pectinatis; lobus intermedius triangularis, recurvus, marginibus breviter denticulatis, apice obtuso; calli laminae basi lineares 4-seriati, deinde ad apicem 6-8-seriati lineares vel sessiles. Columna circiter 2 cm. longa, incurvissima, in dimidio superiore late membranaceo-dilatata, basi bicallosa; anthera breviter mucronata.

Western Australia: Albany District, Rogers, Sep., 1919; York, O. H. Sargent; Cork Swamp, near Perth, Mrs. Tapp, 3/9/07; Swan View, Mrs. W. E. Cooke, 13/9/06.

EXPLANATION OF PLATE XXVII.

Fig. 1. *Ptersostylis decurva*, Rogers. Nat. size.
„ 2. Radical leaves of same, nat. size, not present in the flowering plant.
„ 3. Labellum from above (enlarged).
„ 4. Labellum from below (enlarged).
„ 5. Labellum from the side (enlarged). The claw and basal appendage are well seen.
„ 6. Column from the front (enlarged).
„ 7. Column from the side (enlarged).

ON AUSTRALIAN RHOPALOCERA.

By Norman B. Tindale.

(Contribution from the South Australian Museum.)

[Read October 11, 1923.]

Plates XXVIII. to XXX.

This paper deals with some butterflies contained in the South Australian Museum, and a few notes on synonymy. A list is also given of the species taken by the author on Groote Eylandt and adjacent islands in the Gulf of Carpentaria.

As a result of the acquisition in 1920 of the Lucas Collection of Australian Butterflies, which includes the Illidge Collection, our reference series (which now comprises some 9,000 specimens), was selected from over 20,000 specimens, including collections from W. D. Dodd, W. K. Hunt, R. Illidge, H. G. Stokes, T. O. Thomas, H. Wesselman, and others. The series also includes most of the types of the species described by Dr. T. P. Lucas, and Messrs. E. Guest and J. G. O. Tepper, the type sexes of one species described by Messrs. Waterhouse and Lyell, and eight species described by Mr W. H. Miskin from the Lucas Collection.

Family NYMPHALIDAE.

Euploea usipetes hippias, Miskin.

Pl. xxviii., fig. 1.

The type female, from Thursday Island, described by Waterhouse and Lyell, is now in the South Australian Museum and is figured herein.

Hypocysta adiante antirius, Butler.

Pl. xxviii., figs. 2, 3.

Long series taken on Groote Eylandt and Bickerton Island are very similar to the typical *H. a. antirius,* but specimens are generally much smaller. The posterior ocellus of hindwings often appears to be scaled above, especially in the male, and the wings are more densely scaled than in the Darwin specimens.

Oreixenica orichora flynni, Hardy.

Pl. xxviii., figs. 4-6.

Oreixenica flynni, Hardy, Roy. Soc. Tas. Papers and Proc., 1916, p. 146.

♂. Above. Forewings brown, markings black; markings as in female; discal spots in areas 1a and 2 enlarged, that in area 1a coalescing with subbasal spot; both reaching to cell. Hindwings as in female. Beneath. As in female. Expanse, 34 mm.

Hab.—Tasmania: Cradle Mountain, in January, at about 2,000 feet elevation (Messrs. Carter and Lea). Type of male, I. 13055.

The butterfly was taken in numbers by Messrs. Carter and Lea at the typical locality. The race has not previously been figured; the plate shows the male, female, and a reverse of the male.

Eulepis pyrrhus canomaculatus, Goeze.

Papilio canomaculatus, Goeze, Ent. Beytr., III., i., 1779, p. 88.
Papilio sempronius, Fab., Ent. Syst., III., i., 1793, p. 62.
Charaxes canomaculatus, Kirby, Syn. Cat. Diurn. Lep. Supp., 1877, p. 748.
Eulepis pyrrhus sempronius, Waterhouse and Lyell, Butt. of Austr., 1914, p. 51.

Kirby's correction of the synonymy as above has been overlooked. The little-known paper by Goeze has been responsible for a number of changes.

PRECIS V. VILLIDA, Fab., aberration.

Pl. xxviii., fig. 7.

♂. Above. Forewings brown-black, lighter on termen; two orange bars in cell, no traces of cream discal patch or ocellus, only faint trace of subapical cream spot; orange enclosed ocellus in area 2 small and incomplete. Hindwings grey-brown; a submarginal series of ill-defined light greyish-brown spots forming a broad band, interrupted by veins.

Beneath. Forewings light buff, two broad bars in cell black; centre and cell suffused dusky-orange; a postcellular blackish suffusion; apex and termen devoid of markings; an ocellus in area 2 with orange patch on inner side. Hindwings light buff, devoid of markings. Brisbane (Dr. T. P. Lucas).

A similar aberration from South Australia (E. Guest) differs only in having the ocellus of forewing above larger; two incomplete whitish ocelli on hindwings, bordered on inner side by an orange lunular mark, and the submarginal light greyish-brown spots smaller, nearer margin, and more sharply defined.

PYRAMEIS CARDUI KERSHAWI, McCoy, ab. LUCASI, Miskin.

Pl. xxviii., fig. 8.

Pyrameis lucasi, Miskin, Proc. Linn. Soc. N.S. Wales, 1888, p. 1516.

This aberration (Type, I. 14435) was taken by Dr. T. P. Lucas in Victoria. It appears possible that it is a natural hybrid between *P. kershawi* and *P. itea*, Fab.; it has points of resemblance to both species, and it would be interesting to test this conclusion by breeding experiments.

HYPOLIMNAS MISIPPUS, Linne.

Pl. xxviii., figs. 9, 10.

An interesting female form of this species, taken at Darwin by Mr. T. O. Thomas, has the black apical area of forewing above replaced by an orange-brown suffusion, and the white discal band obscured by orange scales. Beneath, the white band is also obscured and the insect scarcely distinguishable from a specimen of the *inaria* form from India, save that it is smaller. A typical Australian example is figured (fig. 9) for comparison. In Africa and India this species is commonly dimorphic in the female, but this is the first record of a second female form in Australia.

ATELLA PHALANTA ARACA, Waterhouse and Lyell.

Pl. xxviii., fig. 11.

The female of this rare form has not previously been figured. Mr. T. O. Thomas took three specimens at Darwin, and there are several, all males, in our collection. The female appears to be lighter coloured and the hindwing above is less strongly marked.

Family LYCAENIDAE.

NESOLYCAENA ALBOSERICEA, Miskin.

Holochila albosericea, Miskin, Syn. Cat. Rhop. Austr., 1891, p. 65 (March ?).

Holochila (Polyommatus) caeruleolactea, Lucas, Butterflies and Moths, Brisbane, 1891, p. 1 (April 20).

The paper by Lucas was published at Brisbane on April 20, 1891. Miskin's Catalogue is dated 1891, the preface is dated November, 1890, and the answer to an enquiry to the Queensland Museum was "published probably in March"; it would appear that Miskin's name has priority. The status of Lucas' paper has been considered doubtful. It was apparently issued as a separate on the above

date, and reprinted in "The Queenslander," a newspaper, on May 2 and 9, 1891. The "Zoological Record" for 1891 accepts it.

The type male and female of *H. (P.) caerulcolactea* from "hills beyond Duaringa" are in our collection.

CANDALIDES CYPROTUS, Olliff.

Two male specimens, taken by the late Mr. E. Guest at Halbury in September, are a new record for South Australia.

LAMPIDES TRANSLUCENS, Lucas.

Holochila (Polyommatus) translucens, Lucas, Butterflies and Moths, Brisbane, 1891, p 1.

The type (a male) of this species is in our collection. It is said to have been taken by Lieutenant Lucas on the North Australian coast. It is a *Lampides* allied to *L. elpis*, Godart, of India.

OGYRIS ZOSINE, Hew.

The synonymy of this species and its races has become somewhat complicated and needs elucidating. The synonymy is detailed here so as to facilitate reference:—

Ogyris zosine, Hew., Exot. Butt., i., 1853, pl. 1, f. 3, 4. ♂.
O. genoveva, Hew., Exot. Butt., i., 1853, pl. 1, f. 5, 6. ♀.
O. zosine, Hew., Cat. Lyc. B.M., 1862, pl. 1, f. 7. ♂ *(nec* ♀).
O. genoveva, Hew., Cat. Lyc. B.M., 1862, p. 3.
O. zosine, Kirby, Syn. Cat. Diurn. Lep., 1871, p. 425 .
O. genoveva, Kirby, *l.c.*, p. 425.
O. genoveva, Miskin, Trans. Ent. Soc. Lond., 1883, p. 343, pl. 15, f. 1-5. ♂, ♀, and var. *a.*, ♀.
O. genoveva, Miskin, Proc. Linn. Soc. N.S. Wales, 1890, p. 23.
O. genoveva, Waterhouse, Proc. Linn. Soc. N.S. Wales, 1903, p. 245.
O. zosine, Bethune-Baker, Trans. Ent. Soc. Lond., 1905, 278 *et seq.*
O. zosine-duaringa, Bethune-Baker, *l.c.*, p. 280.
O. zosine-magna, Bethune-Baker, *l.c.*, p. 281.
O. zozine, Waterhouse and Lyell, Butt. of Aust., 1914, p. 119 *et seq.*
O. zozine typhon, Waterhouse and Lyell, *l.c.*, p. 120.
O. zozine typhon, f. *iberia*, Waterhouse and Lyell, *l.c.*, p 120.
O. zozine zozine, f. *zenobia*, Waterhouse and Lyell, *l.c.*, p. 120.
O. zozine araxes, Waterhouse and Lyell, *l.c.*, p. 121.
O. zosine, Bethune-Baker, Ann. Mag. Nat. Hist., (8), xvii., 1916, p. 386 *et. seq.*

Hewitson (1853) described and figured the male as *Ogyris zosine*, and on the same page and plate the female as *O. genoveva*, without giving a definite locality for his types. Subsequently (1862) he figured the under-surface of a male, in error, as that of the female of *O. zosine*. Kirby (1871) catalogued *O. zosine* and *O. genoveva* as distinct species, giving "Australia" as the locality for the former and "Moreton Bay" for the latter. Miskin (1883) described and figured both sexes of the species under the name of *O. genoveva*, giving the localities as "Brisbane; Dawson River (Barnard); Queensland," and described and figured a violet form of the female as "var. *a.*, Female." Again in 1890 he gave the synonymy in his revision of the genus. Waterhouse (1903), in his tabulation of synonymy, pointed out that strictly *O. zosine* had priority over *O. genoveva*.

In 1905, Bethune-Baker, in his review of the genus, assuming the privilege of first reviewer, corrected the name of the species to *O. zosine*, and recorded

the type form as being found in "Townsville and its neighbourhood." He also stated, "The 'female' is dimorphic. I have therefore retained the name *genoveva* for the pale-blue 'female' as described by Hewitson." He described as races *O. zosine-duaringa* from Coomooboolaroo, "N. Queensland" (really Southern Queensland), and *O. zosine-magna,* from Brisbane.

Waterhouse and Lyell (1914) gave evidence to show that Hewitson's types came from Moreton Bay (Brisbane), and accordingly restricted the name *zozine* (correctly *zosine)* to the race with dimorphic female, from Southern Queensland and Northern New South Wales; described *O. zozine typhon* with its purple female f. *iberia* from Townsville and north, and *O. zozine araxes* from Victoria, while the purple female of typical *O. zosine* was named f. *zenobia.* They sank *O. genoveva,* Hew., and *O. zosine-magna,* Bethune-Baker, as direct synonyms of *z. zosine,* as also *O. zosine-duaringa,* Bethune-Baker, as not sufficiently distinct to merit even a varietal name.

Bethune-Baker (1916) reviewed the synonymy in detail. He stated *inter alia,* "I definitely selected the dull-purple 'female' as the female type of Hewitson's species. . . . Hewitson himself had described the blue form as *genoveva,* . . . and he did so because he had lying before him the dull-purple form of the 'female' as well as the pale-lustrous one, and this alone justifies me in selecting that form as the type form, but, in view of Hewitson's action, it is the only reasonabe thing to do." He also identified *O. zosine araxes,* Waterhouse and Lyell, the Victorian form, extending to Sydney, as being *O. zosine-magna,* Bethune-Baker (Brisbane). He stated, "From the descriptions it would appear that the two forms must of necessity be the same; knowing the species as well as I do, I feel quite sure they are."

Miskin (1883), really the first reviewer, definitely associated the purple male and the light silvery-blue female from Southern Queensland (Brisbane and Dawson River), and described the violet (purple) female as a variety. The fact that he used the name *genoveva,* Hew.=*zosine,* Hew., does not alter this association in any way, and Miskin himself, although he did not alter the name, was aware of the synonymy (*vide* Proc. Linn. Soc. N.S. Wales, 1890, p. 23). In the absence of further evidence as to the localities of Hewitson's types, Miskin's action would be sufficient, by itself, to fix the typical form as being from Southern Queensland; while, apart from this, Waterhouse and Lyell's selection of "Moreton Bay" as the type locality, cannot be regarded as "pure guess work," for it is well known that Hewitson received most of his material from Diggles, who lived at Brisbane; the evidence of the figures points to the Brisbane form, and, according to Bethune-Baker's statement, a further specimen labelled "Moreton Bay" was associated with the species by Hewitson himself.

Despite Bethune-Baker's statement that he definitely selected the purple form as the female of his typical *O. zosine,* it is nowhere definitely stated so in his 1906 monograph. He, however, stated that the name *genoveva* was retained for the pale-blue female, the above being probably inferred. There is no evidence in any of Hewitson's published work to show that he had before him, and described, the purple female, and, therefore, Bethune-Baker is not justified in selecting it, contrary to Miskin, as the type female.

Waterhouse and Lyell state that Bethune-Baker did not fix a type form, but on page 278 of the 1906 monograph Bethune-Baker does definitely fix Townsville as the type locality. His selection is overruled by that of Miskin.

O. zosine-magna is a direct synonym of *O. z. zosine. O. z. araxes* is the extreme southern race, is apparently not dimorphic, and cannot possibly be identified with the form *O. zosine-magna,* from Brisbane. The Sydney examples, while brighter than the type of *z. araxes,* are not sufficiently distinct from it to form an intermediate race.

Following are notes upon the geographical races so far recognized from Australia:—

OGYRIS ZOSINE TYPHON, Waterhouse and Lyell.

Pl. xxix., fig. 15.

Ogyris z. zosine, Bethune-Baker (*nec* Hewitson, Miskin, and Waterhouse and Lyell).
Ogyris zosine, ♀ f. *genoveva*, Bethune-Baker.

Ranges from Mackay north to Cooktown and also to Darwin. The male is dull purple, the female metallic-blue. The figure is of the female.

OGYRIS Z. TYPHON, f. IBERIA, Waterhouse and Lyell.

Pl. xxix., fig. 14.

Ogyris zosine zosine, Bethune-Baker. ♀.

The dull-purple female form of *O. z. typhon*. Specimens have been taken at Townsville and Cairns.

OGYRIS Z. ZOSINE, Hewitson.

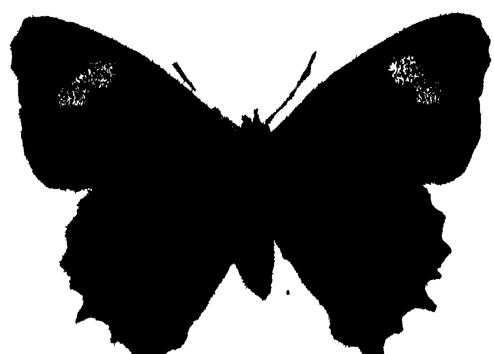
Pl. xxix., fig. 13.

Ogyris zosine-magna, Bethune-Baker.
Ogyris genoveva, Hew., Kirby, and Miskin.
Ogyris zosine-duaringa, Bethune-Baker.
Ogyris zosine zosine, Waterhouse and Lyell.

The type locality is Moreton Bay (Brisbane), and the type form ranges from Duaringa (=Coomooboolaroo) as far south as the Richmond River in Northern New South Wales. Duaringa specimens are not sufficiently distinct to be considered another race.

Text fig. *a* shows a second male form of the typical race from Brisbane. It is smaller than the typical male, the colour is very dull purple, duller than any specimens of *z. typhon*, and the black margins are more pronounced. It expands 45 mm.

Text fig. A.
Ogyris z. zosine, Waterhouse and Lyell, male.



Text fig. B.
Ogyris z. zosine, f. *zenobia*, Waterhouse and Lyell.

OGYRIS Z. ZOSINE, f. ZENOBIA, Waterhouse and Lyell.

Ogyris genoveva, var. *a.*, ♀, Miskin.

The purple female form of typical *O. zosine*. It is much brighter and larger than f. *iberia* of *O. z. typhon*. Mr. R. Illidge has bred and taken a number of specimens at Brisbane. It is also recorded from the Richmond River and Dawson River. Text fig. B shows an example from Brisbane.

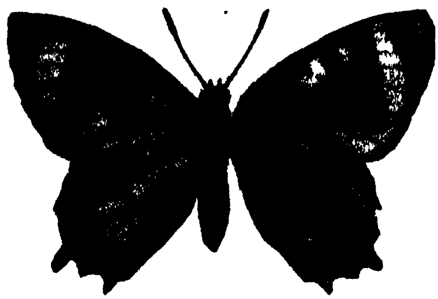
OGYRIS Z. ARAXES, Waterhouse and Lyell.

O. z. magna, Bethune-Baker (*nec* Waterhouse & Lyell).

This is the typically Victorian race of *O. zosine*. Its extreme northern range is Sydney, where it varies a little towards the typical race. It is apparently not dimorphic, no purple female being known.

Ogyris zosine splendida, n. subsp.

Pl. xxix., fig. 12.



Text fig. C.

Ogyris zosine splendida, Tindale, female.

♀. Above. Forewings black; basal two-fifths light metallic-blue, a discal patch between area 2 and vein 6, cream; apex tipped whitish, a small streak in area 7 light blue; cilia whitish, at veins black. Hindwings black, a large central and terminal area light metallic-blue, enclosing three irregularly defined black spots in areas 3 to 5; cilia white, at veins black.

Beneath. Forewings brown; dorsum grey-brown, apex suffused whitish; bar at end of cell black; cell bars broad, white, tinged with bluish, a spot at two-thirds blue; a discal cream patch from near vein 2 reaching vein 10, where it is whitish; the V-shaped mark external to cream patch broadly black. Hindwings brown, markings typical; basal, dorsal and apical areas suffused whitish; central suffusion rich brown, subterminal suffusion light brown. Expanse, 57 mm.

Hab.—South Australia: Mount Painter, Flinders Range (H. G. Stokes). Type, I. 13170.

The greater expanse of light metallic-blue extending to the termen of the hindwings gives this race an appearance very distinct from all the others. The body colour and the down on the hindwing is a light grey. Sufficient material is not available to define the range of the race, but a battered female from Fortescue River, North-western Australia, may belong to it.

OGYRIS OTANES, Felder.

Pl. xxix., figs. 16-19.

Ogyris halmaturia, Tepper, Common Native Insects, Adelaide, ii., 1890, p. 12 (part).
Ogyris halmaturia, Bethune-Baker, Trans. Ent. Soc., Lond., 1905, p. 277.

The name *O. halmaturia* was founded upon two species; the male described is a typical *O. otanes*. The type of *O. otanes* came from Adelaide, and Tepper's specimen from Kangaroo Island. Bethune-Baker, in 1905, examined Tepper's male specimen (he did not see the other described specimen) and separated the island specimens as a distinct species, closely allied to *O. otanes* under Tepper's name. The comparison of 36 specimens (28 mainland, 8 island) reveals no specific differences. All the specimens from South Australia belong to one species. The male, female, and a reverse of the male are figured, together with

Tepper's male specimen. Mr. F. Angel has taken it plentifully at Kingscote, Kangaroo Island, in November.

OGYRIS HALMATURIA HALMATURIA, Tepper.

Pl. xxix., fig. 20.

Ogyris halmaturia, Tepper, Common Native Insects, Adelaide, ii., 1890, p 12 (part).

Considerable confusion has existed regarding this species. The supposed sexes, as described by Tepper, are both males and belong to distinct species. The type male is a typical specimen of *O. otanes*, Feld.; the "female" is the male of a species very close to *O. waterhouseri*, Bethune-Baker, and, as in the original description, the "female" is mentioned and described first, the name *halmaturia* will stand. The typical locality is Kangaroo Island. As no further specimen is known, a description and figure of the type, which lacks both its antennae, is given.

♂. Above. Forewings strongly convex, dull purplish, apex and termen rather broadly black, a few scales at apex white; veins blackish; cilia white, at veins and hinder angle brownish-black. Hindwings dull purplish, costa broadly and termen narrowly brownish-black; veins blackish, with a conspicuous black spot at apex of cell.

Beneath. Forewings brownish, similar to *O. (h.) waterhouseri*, the transverse white bars conspicuous, the apical white bar of cell tinged with brilliant blue, a few scales at apex of cell purple. Hindwings dark brown, suffused whitish, the markings larger than in *O. (h.) waterhouseri*, broadly V-shaped and arranged parallel to margin of wing. A median area brownish-black. Expanse, 50 mm.

Hab.—South Australia: Kangaroo Island, in November (J. G. O. Tepper). Type, I. 14427, unique.

The type is very distinct from *O. idmo*, and cannot be regarded as a race of that species. *O. waterhouseri* is also apparently distinct from *O. idmo*, and should be regarded as a race of the present species. Waterhouse and Lyell associated *O. idmo* and *O. waterhouseri* as races with considerable doubt.

OGYRIS H. WATERHOUSERI, Bethune-Baker.

This form appears sufficiently distinct from the Kangaroo Island form to be regarded as a race. Collectors should look out for both these forms, as very few specimens have ever been taken. The present form has been taken at Dimboola and in the Grampians, Victoria.

OGYRIS ABROTA, Westwood.

A single male taken at Mount Gambier, in April, by the late Mr. E. Guest, is a new record for South Australia.

HYPOLYCAENA PHORBAS PHORBAS, Fab.

Pl. xxix., figs. 23, 24.

Hab.—New Guinea ("Ins. Papuanae"); Queensland: Cape York to Mackay.

Queensland examples are not sufficiently distinct from New Guinea ones to be considered a distinct race. The type form is from "Ins. Papuanae."

HYPOLYCAENA P. PHORBAS, ♂, f. NOCTULA, Staudinger.

There was a specimen of this dark-purple form of the male from North Queensland in the Lucas collection. The markings beneath are pale yellowish-brown and the spots at tornus beneath are prominent, but entirely absent above.

Hypolycaena phorbas ingura, n. subsp.

Pl. xxix., figs. 21, 22.

♂. Above. Forewings black, a large central area dark blue, a large circular patch at end of cell black, no traces of a suffused whitish patch in area 1 *a*, cilia black tipped with white. Hindwings dull black, suffused dark purple, with a series of white subterminal rings at tornus enclosing two black spots; anal lobe faintly centred yellowish, terminal line black, cilia blackish tipped with white.

Beneath. Dull grey, markings typical. Expanse, 34 mm.

♀. Above. Forewings dull black, sometimes traces of a central white patch, cilia black tipped with white. Hindwings dull black, a series of subterminal rings, at tornus enclosing two black spots, one in area 3 bordered with orange, anal lobe with orange centre.

Beneath. As in male, ground-colour usually lighter. Expanse, 40 mm.

Hab.—Northern Territory: Groote Eylandt, January to March; Bickerton Island, April (N. B. Tindale); Darwin, January, December (W. K. Hunt); 12 males, 31 females. Types, I. 14428.

This is the western race of *H. p. phorbas*, Fab., and a comparison with New Guinea and North Queensland examples shows it to be distinct. Only a few Queensland male examples show a tendency to a purple hindwing, while the females of *H. p. ingura* in a series of 31 specimens are all without, or have only a few traces of, the white discal area of forewing. All our specimens of this race are smaller in expanse of wing, this being particularly marked in the island ones.

LIPHYRA BRASSOLIS MELANIA, Waterhouse and Lyell.

Liphyra b. melania, Waterhouse and Lyell, Butt, of Austr., 1914, p. 135. ♂.

♀. Above. Forewings orange, apex and termen broadly brownish-black, costa and termen narrowly edged with brown. A large irregular spot occupying most of cell, and confluent with two large discal black spots in areas 2 and 3. Hindwings orange, a subterminal border brownish-black. Three discal spots in areas 2, 3, and 5. Termen bordered with brown.

Beneath. As in male. No trace of silvery markings, except a small spot below apex of forewings. Expanse, 83 mm.

Hab.—Northern Territory: Groote Eylandt, January (N. B. Tindale); Darwin (W. K. Hunt). Type female, I. 13776.

The two females in our collection are very similar to Queensland examples. The black area in cell above is larger, occupying all of cell except lower portion of basal third, while the dark bands and spots are broader. Beneath is dark brown in the Groote Eylandt example, there being no trace of silvery markings or suffusions. The Darwin example is very worn and faded.

The type female flew to a light at 8.30 p.m. on a sultry night, in my camp at Yetiba, Groote Eylandt, and settled on a ridge pole with wings drooped in such a manner as to be taken at first glance for one of the Ophiderinae, or orange-piercing moths. Another specimen, a male, was seen flying high, around a flowering tree in the scrub about noon, but after several attempts to capture it with a long-handled net, it flew away very rapidly, high over the trees.

Family PIERIDAE.

Delias ennia dorothea, n. subsp.

Pl. xxx., fig. 25.

♂. Above. Forewings white; costa narrowly black; apex black with a series of four white spots. Hindwings white, termen from vein 7 to dorsum black, a faint trace of white subterminal spots.

Beneath. Forewings marked as above, with six, more sharply defined, subapical spots, the costal two bright yellow. Base suffused with yellow. Hindwings white; basal area, from half costa to beyond cell, golden-yellow; termen black, enclosing five large reddish-orange spots; an apical orange spot, and an orange-suffused spot on dorsum. Expanse, 70 mm.

Hab.—Queensland: Coen River (W. D. Dodd). Type, I. 13652.

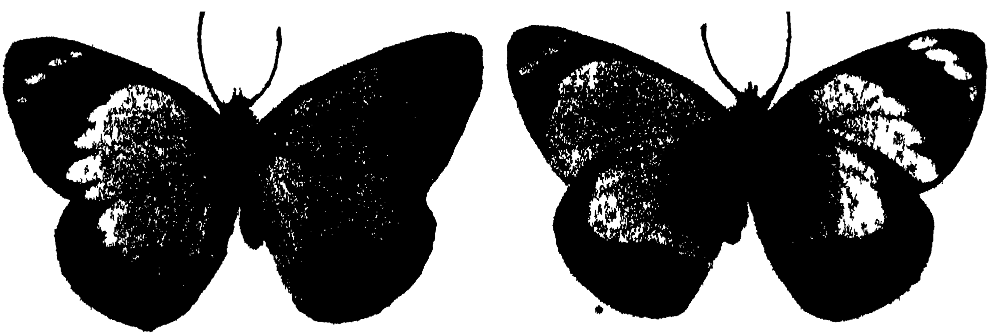
This subspecies is distinguished from the following more southern one by the much larger, and brilliantly orange-coloured terminal spots of hindwings beneath, and by the extension of the yellow basal colour over half the wing. Typical *D. ennia* was described from Waigiou.

DELIAS ENNIA NIGIDIUS, Miskin.

Pl. xxx., fig. 26.

This race is taken in the scrub areas of the Cairns district. A figure is given for comparison with the more northern race The terminal spots of hindwings beneath are deep yellow, and the base of the wing only is suffused with light yellow.

DELAIS M. MYSIS, Fab.



Text figs. D, E

Delias m. mysis, Fabricius, gynandromorph.

There is a gynandromorphic specimen of this species in our collection from Cairns; taken by Mr. A. M. Lea. The left side is marked as in a female, and the right side as in a male. It expands 65 mm. Figs. *d* and *e* show the upper and under surfaces.

Elodina perdita tongura, n. subsp.

♂. Above. Forewings slightly acute at apex, white; base and basal third of costa with scattered dark-brown scales; apex black, inner edge of dark apical area somewhat bisinuate. Hindwings white.

Beneath. Forewings white, base lemon-yellow; a subapical patch light brown. Hindwings white. Expanse, 42 mm.

♀. Above. As in male, apex of forewing more rounded.

Beneath. As in male. Expanse 46 mm.

Hab.—Northern Territory: Groote Eylandt, February to April; Winchilsea Island, April; Woodah Island, April (N. B. Tindale), 16 specimens. Type, male, I. 13777; female, I. 13778.

This island race may be distinguished from *E. p. walkeri* by its larger size, darker black markings, bisinuate inner edge of apical area above, and by the subapical brown patch on forewings beneath. The range of expanse in our series is 42 to 48 mm. In *E. p. walkeri* 32 to 39 mm. The three specimens

from Woodah Island, in Blue Mud Bay, have the subapical patch beneath very faintly visible, but are larger than any specimens of *E. p. walkeri* in our collection. Mainland specimens from Roper River are very typical *E. p. walkeri*. It is also distinct from *E. perdita perdita*. *Tongura* is a Groote Eylandt native (Ingura) word meaning "pipeclay" or "chalk."

ELODINA PADUSA, Hewitson.

A perfect specimen of this species was taken at Mount Painter, in the Flinders Range, by the late H. G. Stokes. This is a new record for South Australia. Mr. R. Illidge has also taken it at Brisbane, though not abundantly. It is the rarest of the genus and has only been recorded so far from single specimens taken in New South Wales, Victoria, and North-western Australia.

Family PAPILIONIDAE.

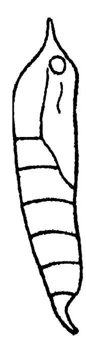
PAPILIO AMYNTOR AMPHIARAUS, Felder.

This interesting species, the only butterfly peculiar to Norfolk Island, has not previously been figured. The specimen, a female, was taken by Mr. A. M. Lea.

EURYCUS CRESSIDA CASSANDRA, Waterhouse and Lyell.

Groote Eylandt specimens are larger than *E. c. cassandra;* in the male they approach typical *E. c. cressida,* but the wings of the females are completely scaled beneath and are distinct from the latter. The butterfly was the most common and conspicuous one seen on the island.

The female was discovered laying eggs on one of the *Aristolochia* vines. The eggs are globular, yellow, with sixteen rows of raised, orange-coloured tubercles, arranged symmetrically; apex with an orange tubercle, the base orange. Diameter, 1 mm. The larvae hatched in ten days. Adult larvae were also obtained, but are not now in condition to be described.



Text fig. F.
Parnara mathias, Fabricius.
Pupa.

Family HESPERIDAE.

PARNARA MATHIAS, Fab.

A pupa was found among grass stems on Groote Eylandt during March, and the butterfly, a female, emerged on May 12. The period of pupation seems long. The pupa was green, smooth and cylindrical, tapering gradually to the anal extremity. Head prolonged in a smooth-pointed horn. Apex of abdomen

curved ventrally and elongated, ending in a laterally flattened, somewhat rounded point. On the dorsum of the live pupa there were longitudinal stripes of pale and darker green showing through the transparent outer shell. Length, 29 mm.; breadth, 6 mm.

LIST OF THE BUTTERFLIES OF GROOTE EYLANDT AND ADJACENT ISLANDS.

Fifty-eight species and varieties were taken on Groote Eylandt during a sojourn extending, with a short break, from June, 1921, to May, 1922. The majority were taken during the rainy season, from November to March.

The records are of interest geographically, for Groote Eylandt lies half-way (measuring along the coastline) between the two main channels of butterfly migration into Australia. Practically not one of the typically New Guinea forms so abundant in Northern Queensland and Cape York has found its way so far west. The prevailing winds in the "wet" season are north-west and west, while south of the Mitchell River in Queensland, as far round the head of the Gulf as Roper River, scrub and rain forests are absent, and the climate is very dry, except for the short rainy season; and these have been barriers to the western extension of the range of these species. Comparatively few of the Timor migrants also have spread so far to the east, so that the species taken in the dense scrubs and rain forests of the island are the widespread, more ancient Australian forms, such as are found over the whole of the northern part of Australia. One notable feature is that specimens of many of the species are smaller than mainland ones. This dwarfing has been noted also by Mr. A. M. Lea in a number of species of Coleoptera. Two exceptions to this are the forms of *Eurycus cressida* and *Elodina perdita*, which are both larger than the usual Northern Territory forms.

In the list, where no islands are specifically mentioned, the records are for Groote Eylandt. The figures after the name indicate the months during which specimens were taken:—

Family NYMPHALIDAE.

Danaida chrysippus petilia, Stoll—1, 2, 7, 8, 11, 12.
D. affinis affinis, Fab.—1, 2, 3, 12.
D. melissa hamata, Macl.—2, 3.
Euploca corinna corinna, Macl.—2, 11, 12.
E. sylvester pelor, Doubld. and Hew.—2.
E. s. pelor, f. *dardanoides*, Waterhouse and Lyell—2.
Mycalesis sirius sirius, Fab.—1, 2, 3, 11, 12.
M. perseus perseus, Fab.—6.
M. p. perseus, f. *infuscata*, Macl.—Groote Eylandt 1, 2, 3, 12; Bickerton Island 4.
Melanitis leda bankia, Fab.—3, 12.
M. l. bankia, f. *barnardi*, Lucas—1.
Hypocysta adiante antirius, Butl.—Groote Eylandt 1, 2, 3, 4, 11, 12; Bickerton Island 4.
Precis villida villida, Fab.—Groote Eylandt 2, 3, 12; Woody Island, 4.
P. orithyra albicincta, Butl.—1, 2, 12.
Hypolimnas bolina nerina, Fab.—1, 3, 11.
H. alimena darwinensis, Waterhouse and Lyell—2, 12.
Cethosia penthesilea paksha, Fruhs.—4, 7.
Acraea andromacha, Fab.—8.

Family LYCAENIDAE.

Candalides erinus, Fab.—Groote Eylandt 1, 2, 3, 4; Woodah Island 4.
Nacaduba ancyra estrella, Waterhouse and Lyell—1, 2, 3, 11.
N. dubiosa, Semp.—12.
Everes argiades, Pall.—3.
Euchrysops cnejus cnidus, Waterhouse and Lyell—1, 2, 3, 12.
Jamides phaseli, Mathew—3.
Catochrysops emolus affinis, Waterhouse and Turner—2, 3.
Chilades trochilus putli, Koll.—Groote Eylandt 2, 3; Woodah Island 4.
Zizina labradus labradus, Godt.—2.
Zizeeria alsulus, Herr.-Schaeff.—Groote Eylandt 1, 3; Woodah Island 4; Bickerton Island 4; Woody Island 4.
Z. lysimon karsandra, Moore—2.
Theclinesthes onycha, Hew.—Groote Eylandt, var.
Arhopala amytis cyronthe, Misk.—2, 11.
A. centaurus asopus, Waterhouse and Lyell—2.
Hypolycaena phorbas ingura, Tindale—Groote Eylandt 1, 2, 3; Bickerton Island 4.
Liphyra brassolis melania, Waterhouse and Lyell—1.

Family PIERIDAE.

Elodina perdita tongura, Tindale—Groote Eylandt 2, 3, 4; Winchilsea Island 4; Woodah Island 4.
Anaphaeis java teutonia, Fab.—7, 8.
Huphina perimale scyllara, Macl.—Groote Eylandt 2, 4, 12; Winchilsea Island 4.
Appias paulina ega, Boisd.—12.
Catopsilia pyranthe pythias, Waterhouse and Lyell—8.
C. pomona pomona, Fab.—7, 8, 11.
Terias hecabe sulphurata, Butl.—1, 2, 3, 7, 8, 11, 12.
T. smilax, Don.—2, 12.
T. sana, Butl.—2, 3, 11, 12.
T. laeta lineata, Misk.—Groote Eylandt 12; Winchilsea Island 4.
T. herla, Macl.—1, 2, 3, 4, 11, 12.

Family PAPILIONIDAE.

Papilio demoleus sthenelus, Macl.—Groote Eylandt 8; Woodah Island 4; Woody Island 4.
P. fuscus canopus, Westw.—1, 2.
P. eurypilus nyctimus, Waterhouse and Lyell—4.
Eurycus cressida cassandra, Waterhouse and Lyell—2, 3, 4, 11, 12.

Family HESPERIDAE.

Toxidia sexguttata, Herr.-Schaeff.—Groote Eylandt 2; Winchilsea Island 4.
Neohesperilla crocea, Misk.—1, 2, 3.
Padraona flavovittata walkeri, Heron—2, 3.
P. sunias, Feld., var.—2, 3.
Telicota augias kreffti, Macl.—2.
Parnara mathias, Fab.—Groote Eylandt 2, 5; Woody Island 4.
Badamia exclamationis, Fab.—4.

EXPLANATION OF PLATES XXVIII. TO XXX.

PLATE XXVIII.

Fig. 1. *Euploca usipetes hippias*, Miskin, Type female, Thursday Island.
„ 2. *Hypocysta adiante antirius*, Butler, male, Groote Eylandt.
„ 3. „ „ „ „ female, Groote Eylandt.
„ 4. *Oreixenica orichora flynni*, Hardy, Type male, Cradle Mountain.
„ 5. „ „ „ „ female, Cradle Mountain.
„ 6. „ „ „ „ male, reverse, Cradle Mountain.
„ 7. *Precis v. villida*, Fab., aberration, Brisbane.
„ 8. *Pyrameis c. kershawi*, McCoy, ab. *lucasi*, Miskin, Victoria.
„ 9. *Hypolimnas missipus*, Linné, female, normal form, Kuranda.
„ 10. „ „ „ female, variety, Darwin.
„ 11. *Atella phalanta araca*, Waterhouse and Lyell, female, Darwin.

PLATE XXIX.

Fig. 12. *Ogyris zosine splendida*, Tindale, Type female, Mount Painter.
„ 13. „ „ *zosine*, Hew., female, Brisbane.
„ 14. „ „ *typhon*, female, f. *iberia*, Waterhouse and Lyell, Townsville.
„ 15. „ „ „ Waterhouse and Lyell, female, Townsville.
„ 16. „ *halmaturia*, Tepper, Type male, Kangaroo Island = *otanes*, Felder.
„ 17. „ *otanes*, Feld., male, Kangaroo Island.
„ 18. „ „ „ „ reverse, Adelaide.
„ 19. „ „ „ female, Adelaide.
„ 20. „ *h. halmaturia*, Tepper, Type, a male, Kangaroo Island.
„ 21. *Hypolycaena phorbas ingura*, Tindale, Type male, Groote Eylandt.
„ 22. „ „ „ „ „ female, Groote Eylandt.
„ 23. „ „ *phorbas*, Fab., male, Townsville.
„ 24. „ „ „ „ female, Townsville.

PLATE XXX.

Fig. 25. *Delias ennia dorothea*, Tindale, Type male, Coen River.
„ 26. „ „ *nigidius*, Miskin, male, Kuranda.
„ 27. *Elodina perdita tongura*, Tindale, Type male, Groote Eylandt.
„ 28. „ „ „ „ „ female, Groote Eylandt.
„ 29. *Papilio amyntor amphiaraus*, Feld., female, Norfolk Island.
„ 30. *Liphyra brassolis melania*, Waterhouse and Lyell, Type female, Groote Eylandt.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 11—THE COLEOPTERA OF PEARSON ISLAND.

By ARTHUR M. LEA, F.E.S., Museum Entomologist.
(Contribution from the South Australian Museum.)

[Read October 11, 1923.]

PLATE XXXI.

In No. 4 of this series of papers the only beetle recorded from Pearson Island was *Saragus oleatus*, Carter[1]; the special visit to the island in January of this year enabled more species to be taken (for notes on this visit see *ante* p. 97). The most interesting species obtained was a new *Mandalotus*, which at the request of Prof. F. Wood Jones I have pleasure in naming after Sir George Murray.

CARABIDAE.

Scopodes sigillatus, Germ. *Simodontus australis*, Dej.

TROGOSITIDAE (?).

Phycosecis algarum, Pasc. (Pl. xxxi. fig. 1.) Several specimens were obtained on the island; the species is common on the beaches of New South Wales and Tasmania. The derm of the head is usually black, the other parts are usually pale castaneous, but vary to black; the upper-surface is clothed with scales that are normally snowy-white, but there is frequently a large median blotch extending from apex of prothorax to beyond the middle of elytra, which is stramineous or pale brown; the elytral punctures are normally concealed, but are indicated through the clothing; there is a beautiful fringe of long silvery hairs on the prothorax and elytra. Specimens, however, are very easily damaged, the scales and fringes are often partly abraded, and the scales are easily stained.

LATHRIDIIDAE.

Corticaria adelaidae, Blackb.

SCARABAEIDAE.

Pseudopimelopus lindi, Blackb.

BUPRESTIDAE.

Germarica casuarinae, Blackb.

ELATERIDAE.

Two specimens of this family were obtained; one of a species too near the description of *Cardiophorus octavus*, Cand., from the Swan River, for it to be described as new; the other a small *Monocrepidius*, which cannot be satisfactorily dealt with at present.

(1) *Ante*, 1922, p. 297.

MALACODERMIDAE.

Laius cinctus, Redt. *Hypattalus minutus*, Lea.
Dasytes fuscipennis, Hope.

CLERIDAE.

Necrobia rufipes, De Geer.

PTINIDAE.

Pitnus[2] australiae, n. sp.

Pl. xxxi., fig. 2.

Black. Clothed with rather stout, subdepressed, white setae, on the elytra confined to a regular row on each interstice.

Head directed downwards and invisible from above. Eyes small and prominent. Antennae eight-jointed, first and eighth rather large, the others small, the eighth appearing as a conspicuous one-jointed club. Prothorax subopaque, slightly transverse, base and apex subequal, sides strongly rounded, punctures rather ill-defined. Elytra subelliptic, strongly convex, shoulders strongly rounded, median width fully twice that of prothorax; with rows of large, subquadrate, approximate punctures, the interstices narrow and indented by punctures. Abdomen with second segment large, its suture with first distinct at sides, but inconspicuous in middle, third and fourth small and curved, the fourth almost semicircularly enclosing the fifth. Legs rather thin. Length, 1-1 75 mm.

The diagnosis of *Pitnus*, and the description of the only then known species (*P. pygmaeus*) from Central America, are very brief, but the details given and the figure[3] represent an insect so greatly resembling the one before me that I think it must belong to the same genus. The Australian species has but eight joints to its antennae, the Central American one has nine (in the figure ten are shown, but this was noted as an error). Four specimens were obtained on Pearson Island, but the species occurs in abundance on saltbushes (*Atriplex* spp.) growing near beaches in South Australia (Kangaroo Island, A. H. Elston; Sleaford Bay, Rev. T. Blackburn) and Western Australia (Swan River, J. Clark and A. M. Lea; Geraldton, T. Hooper and Lea; and Pelsart Island, Lea). The specimens from Pelsart Island and some from the Swan River are decidedly smaller than the others, but, apart from size, I can find no differences between them and the larger ones. Wings are completely absent.

Pronus, n. gen.

Head rather large, projecting downwards and quite concealed from above; under-surface with a shallow depression between bases of eyes, but not bisinuate. Eyes moderately large, round, and with facets of moderate size or small. Antennae eleven-jointed, first joint large, the next seven small, the others forming a large, loosely compacted club. Palpi with apical joint wide and incurved at apex. Prothorax with base bisinuate. Scutellum distinct. Elytra striate or striate-punctate. Prosternum with middle normally concealed by head, with triangular side-pieces facing backwards; with grooves for reception of sides of head. Mesosternum very short, vertical in middle. Metasternum moderately long, side pieces distinct throughout. Abdomen composed of five distinct segments. Legs not capable of being received in special cavities; front coxae strongly projecting, pressed backwards, their tips in contact, hind coxae moderately separated, their sides touching elytra, grooved for partial reception of femora, all tarsi short, basal joint about as long as two following combined.

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(2) Gorham, Biol. Cent. Am., Col., iii., Part 2, p. 197.

(3) *L.c.*, pl. 10, fig. 8.

This genus is evidently near *Sitodrepa*, but differs in the sides of the prosternum, these being so shaped that the head when at rest has the mandibles resting on the front and middle coxae, the front ones being flattened backwards to allow of this; the front and middle legs on each side are received into a space between the sides of prosternum, mesosternum, and an elytron, but there are no special grooves for their reception. From above the general appearance is as in the Hawaiian genus *Holcobius*, but the three apical joints of the antennae are large, and form a loosely compacted club. In addition to the typical species two others of the genus are before me; one of these is here described, but the other, from Queensland, is represented by two badly damaged specimens that it is undesirable to name. Type of genus, *P. medianus*.

Pronus medianus, n. sp.

Pl. xxxi., fig. 3.

Dull castaneous-brown, under-surface of head and antennae paler. Densely clothed with short, depressed, pale pubescence, on the prothorax somewhat waved and conspicuously parted in the middle.

Head with dense and small, partially concealed punctures, a narrow oblique ridge from each eye to clypeal suture. Antennae with basal joint and three joints of club large, some of the small ones serrated. Prothorax with punctures as on head, median line narrow but distinct. Elytra parallel-sided to near apex, evenly striated throughout, some of the striae joined posteriorly but not decreasing in depth, with rather narrow punctures; interstices densely and minutely punctate or shagreened. Metasternum with crowded shallow punctures, distinctly larger than those on abdomen; median line narrow. Basal segment of abdomen in middle slightly longer than second, and shorter than fifth, the three median ones with straight sutures. Length, 4-5 5 mm.

A dingy species, somewhat resembling *Sitodrepa panicea* on an enlarged scale. Three specimens were obtained on the island, and they all have the prothoracic pubescence somewhat waved and conspicuously parted in the middle. Type, I. 15685.

Pronus magniventris, n. sp.

Dull castaneous-brown, under-surface of head and antennae paler. Densely clothed with depressed, very short, pale pubescence.

Head with crowded and small punctures; a narrow oblique carina from each eye to clypeal suture. Antennae with first joint large, fourth to eighth inwardly triangular, ninth (first of club) largest of all, the tenth and eleventh large. Prothorax with crowded and small punctures, median line scarcely traceable. Elytra rather long, parallel-sided to near apex, strongly and evenly striated, the striae with rather small punctures; interstices separately convex, with minute punctures or shagreened. Metasternum with crowded and shallow but fairly large punctures, conspicuously larger than on abdomen; median line narrow. Basal segment of abdomen in middle somewhat longer than second or fifth, the three median ones with straight sutures. Length, 6-6·5 mm.

Hab.—Western Australia: Swan River (A. M. Lea).

In general appearance fairly close to *P. medianus*, and the prothoracic pubescence is slightly waved, but it is not conspicuously parted in the middle.

A specimen from New South Wales (Galston) is certainly close to this species, but it is darker, has smaller eyes (this, however, may be sexual), and there is a more distinct, although feeble, gutter on each side of the pronotum; but as in other respects it agrees closely with the types, it was not regarded as distinct.

TENEBRIONIDAE.

Caedtomorpha heteromera, King. *Helaeus castor*, Pasc.
Cestrinus aspersus, Blackb. *Saragus oleatus*, Carter
Exangeltus gracilior, Blackb.

CURCULIONIDAE.

In addition to the other species recorded, a single specimen was obtained of an interesting one belonging to the same genus as *Myositta crucigera*, Blackb, but which Blackburn afterward stated did not belong to *Myositta*, but probably to *Agestra*. Unfortunately it is an abraded female, so it is undesirable to name it.

Euthyphasis lineata, Lea. Three specimens from the island appear to belong to this species, of which previously only the type was known; they differ from it in having the clothing less lineate in appearance on the prothorax, and not at all lineate on the elytra, on one of them it has a distinctly golden gloss on the upper-surface. and a slight gloss on the under-surface; on the others the gloss is faint on the under-surface, and on the upper-surface the scales are mostly of an opaque white, mixed with muddy-grey. The type was not abraded, but one of the island ones has been partly abraded, and its elytral punctures are seen to be large, close together, and wider than the interstices.

Mandalotus murrayi, n. sp.

Pl. xxxi, figs 4, 5.

♂. Castaneous to dark brown, some parts occasionally almost black. Densely clothed with pale scales, obscurely or moderately mottled with small patches of greyish or brownish ones; in addition with numerous pale setae, on the elytra condensed to form a single row on each interstice.

Head with punctures concealed. Eyes small. Rostrum gibbous between antennae, derm concealed. Antennae with scape slightly curved and moderately stout, almost as long as funicle and club combined, first joint of the latter stout and moderately long. Prothorax moderately transverse, sides somewhat dilated to apical third and then strongly narrowed to apex; with small, flattened granules, and a rather feeble median line. Elytra gently but not quite evenly arcuate at base; striate-punctate, punctures large but appearing small through clothing, interstices gently convex, with dense and small, concealed punctures. Abdomen with basal segment somewhat flattened, with two small tubercles close together at the middle of its apex. Front coxae almost touching, middle ones moderately, the hind ones widely separated. Length, 3·75-4·25 mm.

♀. Differs in being slightly more robust, basal segment of abdomen gently convex, without tubercles, and legs and antennae slightly shorter.

The two small tubercles on the abdomen of the male associate this species with *M. lutosus*, but on that species the small tubercles are so placed that the distance between them is about equal to the length of the second segment; on the present species they are closer together, the distance between them being scarcely half the length of that segment; the present species also is larger, with the scape and basal joint of antennae stouter, and setae of elytra pale instead of dark. On three specimens the colour of the derm is almost black, on three others it is almost entirely castaneous, but on most of the others the prothorax is distinctly darker than the elytra. Type, I. 15723.

Rhinaria maculiventris, n. sp.

Black or blackish-brown, some parts obscurely paler. Densely clothed with scales conspicuously variegated on upper-surface, white on under-surface except

for dark spots on each side of third and fourth abdominal segments; in addition with numerous stout setae, wider on under-surface than elsewhere, seriate on elytra, and becoming thin on legs.

Head with dense punctures, each containing a scale; a comparatively small crest in front, posteriorly diverging to margin of each eye for a short distance. Rostrum short, concave, and with a few punctures along middle; sides flat, highly polished, and with rather sparse, conspicuous punctures. Club of antennae elongate. Prothorax with sides strongly and evenly rounded; punctures dense and rather large, but almost concealed. Elytra conspicuously wider than prothorax, sides parallel to near apex; with rows of large, partially concealed punctures, each containing a stout seta or scale; interstices evenly convex and wider than punctures, each with a row of setae, and towards base with small granules. Length, 7-9 mm.

The rostrum concave along the middle and polished on the sides, elytra with even interstices on which granules are few and inconspicuous, and the maculate abdomen distinguish this from all previously described species. Structurally it is closer to *R. faceta* than to any other species before me, but that species has distinct rows of granules and a white fascia on elytra, sides of rostrum clothed, and abdomen immaculate. As on most species of the genus, the markings of the upper-surface are variable, the scales are black, white, and ochreous, intermingled in small patches, on some specimens the white scales are in the majority, on most of the others the ochreous ones are, but these vary from almost white to dark brown; the scutellum, however, appears to be always clothed with white scales. The granules on the elytra are all small and are mostly on the basal half, but they are usually concealed by the clothing; the seriate punctures appear to be narrower than the interstices, but after the scales have been abraded they are seen to be slightly wider than them. The male has slightly longer legs than the female, and the basal segment of its abdomen is slightly depressed in the middle, that of the female being slightly convex there. A single specimen was taken on the island, but Messrs. B. A. Feuerheerdt and F. Secker took others at Lucindale.

Belus brunneus, Guer. Fragments of at least nine specimens of this species were taken from the stomach of a thickhead (*Pachycephala gutturalis*).

Desiantha maculata, Blackb. In the original description of this widely distributed species the under-surface was not even mentioned; on the male there is a conspicuous depression on the basal segment of abdomen, continued on to the second segment and also on to the metasternum; its apical segment has a small median fovea, sometimes scarcely traceable. On the female the basal segment is convex in the middle and the apical one has a cavity occupying rather more than the median third; its metasternum has a large depression but smaller than on the male. Numerous specimens from the island may represent a variety of the species, they differ from some cotypes and other specimens in the average size being larger (up to 6 5 mm.), the elytra less conspicuously maculate, and the scales occasionally with a golden or golden-green gloss.

Xeda, sp. A single badly abraded specimen of this genus was obtained; it belongs to a large species about the size of *X. magistra* or *X. fasciata*, but could not be identified with certainty.

Decilaus auricomus, Lea.

Eleagna squamibunda, Pasc.

Aphela algarum, Pasc.

A. helopoides, Pasc. One of the specimens of this apterous beach-frequenting species was taken from the stomach of *Hirundo neoxena*, a rather curious record for this bird, which usually captures its prey on the wing.

Halorhynchus caecus, Woll. (Pl. xxxi., fig. 6.) Several specimens were obtained. Although a widely distributed species, it seems remarkable that this curious, little, apterous, blind species should occur on such a small island.

COCCINELLIDAE.

In addition to the species noted a single specimen was obtained of a minute species probably belonging to *Scymnus*, and about the size of *S. vagans;* it differs from that species in the eyes having coarser facets, metasternum with smaller punctures, and prothorax obscurely reddish; but as its sex is not evident, and it appears to be partly abraded, it does not appear desirable to name it.

Scymnus flavifrons, Blackb. A small form of this variable species; the elytra entirely dark, or with only the tips obscurely reddish.

Rhizobius nitidus, Blackb. A single specimen was obtained on the island; it, and all the others before me, have the suture very narrowly blackish, a character not mentioned in the original description.

Coccinella transversalis, Fab.

CORYLOPHIDAE.

Sericoderus inconspicuus, Lea.

EXPLANATION OF PLATE XXXI.

Fig. 1. *Phycosecis algarum*, Pasc.
„ 2. *Pitnus australiae*, Lea.
„ 3. *Pronus medianus*, Lea.
„ 4. *Mandalotus murrayi*, Lea.
„ 5. *Mandalotus murrayi*, Lea.
„ 6. *Halorhynchus caecus*, Woll.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 12—STOMACH CONTENTS OF PEARSON ISLAND BIRDS.

By ARTHUR M. LEA, F.E.S., Museum Entomologist.
(Contribution from the South Australian Museum.)

[Read October 11, 1923.]

This paper deals with the stomach contents of a few birds obtained on Pearson Island and commented upon by Prof. J. B. Cleland in No. 9 of this series (*ante*, p. 119). Only the technical names of the birds are given here. For the names of parts of plants we are indebted to Mr. J. M. Black.

Chalcites basalis, Horsf. Crammed with small hairy caterpillars; one lady-bird beetle, *Coccinella transversalis*.

Hirundo neoxena, Gould. Small fly, Muscidae; bits of many minute flies; bits of small flying ants; beach weevil, *Aphela helopoides;* many other minute fragments of insects.

Petroica goodenovii, V. & H. (1) Large caterpillar, probably Hepialidae; sand beetle, *Cestrinus aspersus*. (2) Forceps of two earwigs, *Anisolabis australis;* bits of two beach weevils, *Decilaus* sp.; bit of leaf-eating beetle, *Tomyris* sp.; bits of small spider; fine grit.

Pachycephala pectoralis, Lath. (1) Crammed with fragments of thin plant weevil, *Belus brunneus;* nine heads of this destructive species were counted. (2) Three small moths; eight small caterpillars; small ant, *Pheidole* sp.; small jumping spider, Attidae; many minute fragments of insects.

Ephthianura albifrons, J. & S. (1) Bits of small destructive weevil, *Desiantha maculata;* bits of two small tenebrion beetles, *Micrectyche* sp.; head of small flying ant; other minute fragments of insects; numerous fruiting perianths of *Threlkeldia diffusa*. (2) Bits of larval grasshopper, *Coryphistes obscurobrunneus;* bits of small weevil, *Desiantha maculata;* bits of two tenebrion beetles, *Micrectyche* sp.; head of minute beetle; numerous fruiting perianths of *Threlkeldia diffusa*.

Zosterops lateralis, Lath. (1) Bits of small dipterous flies; bits of small plant bug, Pentatomidae; twenty fruiting perianths of *Threlkeldia diffusa*, one of *Enchylaena tomentosa*, and one of globular fruit, probably of an *Eremophila*. (2) Three small caterpillars; two larger ones; two larval membracid bugs; head of small clavicorn beetle; a few unidentified fragments; numerous fruiting perianths of *T. diffusa*. (3) Crammed with small yellow flies and fragments of others.

Corvus coronoides, V. & H. Seven caterpillars; bits of large larval grasshopper, *Coryphistes obscurobrunneus;* bones probably of small lizard; fruiting perianth of *Threlkeldia diffusa*.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 13—ORTHOPTERA.

By Norman B. Tindale.

(Contribution from the South Australian Museum.)

[Read October 11, 1923.]

Plate XXXII.

The small collection which is the subject of this paper was made by Prof. F. Wood Jones. The islands from which specimens were received are Pearson, Greenly, South Neptune, Price, and Franklin. A grasshopper and an earwig are described and figured as new, and the male, previously unknown, of the cockroach *Platyzosteria brunnea,* Tepper, is figured. Several of the species are also recorded from the Sir Joseph Banks Group, from specimens taken by the author during March, 1923.

ORTHOPTERA.

Family BLATTIDAE.

Loboptera halmaturina, Tepper. Four specimens were taken on Pearson Island, and others on Reevesby Island and at Mount Lofty, and they agree well with Tepper's types from Kangaroo Island.

Calolampra irrorata, Fabricius. Two immature specimens from Pearson and St. Francis Islands. Also taken on Spilsby Island.

Calolampra notabilis, Tepper. An immature male from South Neptune Island and a male from St. Francis Island.

Platyzosteria brunnea, Tepper. (Pl. xxxii., figs. 1, 2.) Seven males and three females were taken on Pearson Island. The species was described from Gilbert River and Kangaroo Island, and the specimen described by Tepper as a male is a female. A male of the species *P. communis,* Tepper, was also described as belonging to the present species. A figure of the male is given, and one of the type female, to show the apex of abdomen. The male closely resembles the female, but is generally smaller, the supra-anal lamina is less strongly developed, and less serrated. The supra-anal lamina is generally notched at apex, but in one specimen taken the notch is absent. The colour in all specimens is a dark brownish-black, and the lateral margins of pronotum, mesonotum, and metanotum have a submarginal pale-yellowish vitta. The antennae are brown with the base darker.

Oniscosoma granicollis, Saussure. A female from Pearson Island and two larvae from Reevesby Island.

Family PHANEROPTERIDAE.

Taeniomena soror, Brunner. Price Island, one male.

Family ACRIDIIDAE.

Urnisa rugosa, Saussure. A female of this species was collected on Franklin Island. The species is very close to *U. erythrocnemis,* but can be at once distinguished by the dull-purplish apical half of the posterior tibiae, the lighter

reddish colour of the basal half, and the inner face of the femora. It has been confused with *O. sobria*, Walker=*U. erythrocnemis*, Stal.

Coryphistes obscurobrunneus, Tepper. A female from Franklin Island. Both sexes were taken on Reevesby Island by burning the low scrub.

Peakesia rugosa, n. sp.

Pl. xxxii., figs. 4, 5.

♀. Head with frontal costa deeply excavated above and below ocellus, margins wavy, not parallel, narrowest below ocellus. Fastigium of vertex long, somewhat broad, impressed, apex bluntly triangular, sides slightly converging posteriorly, median carina of vertex ending abruptly within base of fastigium; antennae short, stout, the joints short and swollen. Pronotum rugged, angular, transverse in front, sides retreating; the posterior lobe produced; three longitudinal well-developed carinae on pronotum above, the outer ones diverging posteriorly, three moderately deep transverse sulci, which, viewed from the side, give the appearance of two rounded swellings in the median carina; anterior and posterior margins densely punctured; inferior margin angular, rounded, lowest in middle; prosternal tubercle long, cylindrical, slightly compressed.

Dark brownish, vertex and upper-surface of pronotum lighter, antennae brown, apical half darker. Pronotum brownish, the carinae obscurely marked with darker brown. Elytra with basal portion dark brown, the fore-margin and apex light brown, obscurely spotted with darker brown. Wings hyaline, apex darkened, base suffused pale yellowish. Anterior and median legs brown; posterior legs with femora brown, obscurely marked with brownish-black on internal and external margins above; the tibiae brown, the basal fifth lighter. Length with elytra 28 mm., abdomen 17 mm., pronotum 6 5 mm., antennae 8 mm., elytra 20 mm., posterior femora 16 mm., posterior tibiae 13 mm.

Hab.—South Australia: Greenly Island (F. Wood Jones). Type female, I. 14429.

Three specimens were taken; one was bleached with spirit and a second specimen rather shrivelled. The species is allied to *P. palliata*, Sjostedt, but differs from that species in its smaller size, broader fastigium, short, thick-set antennae, angular pronotum, and brownish posterior tibiae.

Peakesia palliata, Sjostedt. (Pl. xxxii., fig. 3.) There is before me a single specimen of this species from Ooldea (A. M. Lea) which agrees well with Sjöstedt's description and figure. It has the posterior femora pale brown and the tibiae dull green (in the type they were missing). A figure is given for comparison with *P. rugosa*.

Phaulacridium gemini, Sjöstedt. Three females were taken on Pearson and Greenly Islands. They were all of the semi-apterous form and differ somewhat from mainland specimens.

Family LABIDURIDAE.

Labidura truncata, Kirby. A male and female of the fully winged form of this species were taken on Pearson Island.

Anisolabis australis, n. sp.

♂. Head smooth, convex, almost circular in outline, but anterior portion produced; eyes small, projecting a little, viewed from above nearly triangular and longer than wide; antennae short, 14-jointed, the basal joints ovate, becoming more elongated towards apex; the basal joint long, the second small, the third large, nearly as long as fourth and fifth combined. Pronotum almost a square; slightly wider posteriorly, smooth, with a median and latero-marginal sutures; mesonotum rectangular, wider than long, with median suture well developed;

metanotum transverse, the posterior margin concave, suture not prominent. Abdomen smooth, polished, the fifth and sixth segments widest, narrowing posteriorly; last dorsal segment large, transverse, narrowed posteriorly, a median sulcus and lateral sulci distinct; a swelling on posterior margin above the keel of forceps. Forceps short, stout, subcontiguous, above with a keel; inner margin with a number of small teeth on basal half.

Head black with the antennae brown. The thorax brownish, the abdomen brownish-black becoming darker posteriorly; the last dorsal segment and forceps somewhat reddish-brown. Legs light brown, with a darker area on anterior margin of femora. Length, 10 mm.

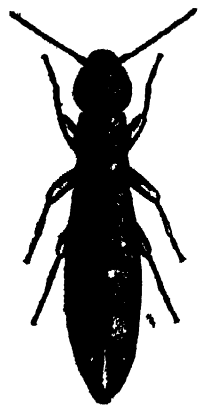


Fig. A.
Anisolabis australis, Tindale.
Male.

♀. Similar to the male, larger, antennae 13-jointed, the forceps contiguous, stout, more sinuate on outer margin. Length, 12 mm.

Hab.—South Australia: Pearson Island (T. D. Campbell, F. Wood Jones), Spilsby and Reevesby Islands (N. B. Tindale). Types, I. 14430.

The species is represented from Pearson Island by five immature specimens and one damaged female. The type specimens were taken together under a stone on Spilsby Island and were at first confused with the cosmopolitan *A. annulipes*, Lucas, but a comparison with Adelaide specimens of that species shows them to be quite distinct. The male has the forceps of a different type, more symmetrical, wider at base, and less incurved at apex. The number of joints of the antennae in the thirteen specimens examined ranges from 12 to 14, and the 14-jointed specimens are all males.

EXPLANATION OF PLATE XXXII.

Fig. 1. *Platyzosteria brunnea*, Tepper, male, Pearson Island.
„ 2. „ „ „ type female, Gilbert River.
„ 3. *Peakesia palliata*, Sjöstedt, female, Ooldea.
„ 4. „ *rugosa*, Tindale, type female, Greenly Island.
„ 5. „ „ „ cotype female, Greenly Island.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 14—THE BASIDIOMYCETOUS FUNGI OF PEARSON ISLAND, GREAT AUSTRALIAN BIGHT.

By J. Burton Cleland, M.D.

[Read October 11, 1923.]

Considering that the visit of Professor Wood Jones' party to Pearson Island was in the middle of summer (January, 1923), and had been preceded by a long spell of dry weather, and that, as far as fresh water is concerned, this island is practically waterless, the utmost that could be expected was that a few woody bracket fungi and dried puff-balls might be found. No idea would be obtained of the species of fleshy agarics and of delicate, more ephemeral kinds that doubtless are to be met with during the wet season. These expectations were realized. These records, therefore, in no way indicate, as far as concerns the higher fungi, the floral potentialities of this island.

The spores of the higher fungi, in many cases liberated in millions from the fruiting bodies, may, according to Buller (Researches on Fungi), take about half a minute to fall an inch in a perfectly still atmosphere. When currents of air catch them, they may remain almost indefinitely suspended, according to the direction of these, and may be wafted hither and thither, doubtless over enormous distances. In this way the spores probably of many species on the adjacent and even distant parts of the mainland of Australia get carried into the upper regions of the atmosphere and may be directed by favourable winds to this small island 40 miles from the coast. To germinate and establish themselves they require the particular organic menstruum necessary to them, as well as suitable conditions of warmth and moisture. Of the spores of many species reaching the island, few are likely to find the exact conditions they require. In this connection, it was interesting to find the presence of the bracket fungus, *Polyporus decipiens*, a purely Australian species found growing on dead or living *Casuarina* wood, and rarely, if at all, on the wood of other genera. Here, again, it was met with on the dead wood of *C. stricta*, Ait.

But, apart from wind dispersal and from the accidental introduction of spores attached to the clothing and other accompaniments of the few human beings who have visited this island, there is another way by which the presence of certain fungi may be explained. They may represent the descendants of species occupying this area of land when it was separated, ages ago, from the mainland. It is impossible to suggest that any particular species found, more than another, had such an origin—all, some, or none may have been so derived.

Two polypores and a *Corticium* represent the only members of the Hymenomycetes found.

Amongst the Gasteromycetes, there were four species of *Geaster*, a rounded *Polysaccum*, a *Lycoperdon*, and a *Catastoma*. Of particular interest was the finding of *Geaster fornicatus*, arising from a mass of whitish mycelium binding together fragments of soil and vegetable débris, in exactly the same way as in specimens from Mullumbimby, in New South Wales, found by the writer. The only other additional locality in which I have found this species was near Hallett's

Cove in South Australia. As an anomaly, a specimen of one *Geaster* showed the presence of two mouths.

Polystictus cinnabarinus, Jacq. On dead wood. A widely distributed species probably occurring throughout Australia.

Polyporus (Hexagona) decipiens, Berk. On dead wood of *Casuarina stricta*, Ait., near the summit of the tallest peak. Spores pallid brown, 17·5 to 19×8 to 9·5 μ. Associated with these typical specimens, but growing from the upper surfaces of the logs, were sessile, or nearly completely sessile, nummular round or oval polypores, the largest 18×15 mm., the others 11 mm. or less in size. The substance was thin, the upper surface marked with shallow rather hexagonal honeycomb-like pits, varying in diameter in different specimens from about 1 to 3 mm. The size of the orifices was considerably larger than in typical *H. decipiens*. The colour also was a dark cinnamon-brown, in contrast to the greyish-brown of the normal hymenial surface. The spores, however, were of the pallid brown colour of those of *H. decipiens* and obliquely elliptical to rather mummy-shaped. Their size was somewhat larger than in the case of the normal plants, being 22·5×9·5 μ. I have no doubt that these were merely abnormal examples of *H. decipiens*, growing in an unusual situation, the upper surface of a fallen log.

Corticium sp. A milk-white *Corticium*, found on a fallen log, seems close to *C. lacteum*, Fr. Waxy-membranaceous, effused, but the edge not fibrillose, flesh slightly isabelline, spores not seen.

Polysaccum pisocarpium, Fr., var. *tuberosum*. Globose, 2·5 cm. in diameter, surface now pallid, spores rough, 8 to 9 μ.

Lycoperdon polymorphum, Vitt. Sterile base definite, of small cells. Moderately developed root. Spores yellow-brown, smooth or slightly rough, 5 μ; capillitium brown, branching, ends blunt, 2·5 to 5 μ in diameter.

Catastoma sp. A single battered specimen was obtained. Exoperidium ill-defined, mouth not now recognizable, gleba "Prout's Brown" (Ridgway, pl. xv.). Spores yellow-brown, smooth, pedicles not seen, spherical to slightly irregular or slightly oval, 4 to 6 μ; capillitium brown, 2 to 3·5 μ in diameter, usually in short lengths with blunt ends and with occasional knob-like thickenings.

Geaster minimus, Schw. Under *Casuarina*, etc., near the summit of the tallest peak; the other Geasters were found in the same situation. Spores dark brown, slightly rough, 6 μ.

Geaster fornicatus, Batt. A number of typical specimens were found amongst the leaf-mould near *Casuarinas*, etc. The mould was permeated through and through with the white mycelium which bound the particles together so that it could be lifted in considerable masses. Spores dark brown, very slightly rough, 6 μ.

Geaster saccatus, Fr. Some badly damaged old specimens appear to belong to this species.

Geaster sp. Exoperidium not incurved, divided beyond the middle into about 9 to 11 narrow acute lobes. Endoperidium dark coloured, now smooth; mouth sulcate, scarcely protruding. Gleba dark purplish-brown. Spores very dark brown, rough, 6·5 μ.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA.

No. 21.

By J. M. Black.

[Read October 11, 1923.]

Centrolepidaceae.

Centrolepis Murrayi, n. sp. Herba annua nana glabra 5-6 mm. alta, foliis subulatis, laminis 3-6 mm. longis, vaginis perbrevibus, foliis interioribus ad vaginas accretas bracteiformes reductis basin bractearum floriferarum arcte amplexantibus, scapis nullis, bracteis floriferis sessilibus aut subsessilibus folia aequantibus, exteriore cum laminâ vel aristâ foliaceâ parti vaginanti aequilongâ, interiore exaristatâ mucronulatâ, flore solitario intra bracteas et sine squamis, carpellis 8-10.

Centrolepis Murrayi.—A, plant enlarged. B, the 2 floral bracts embraced at base by the broad sheath of an inner leaf C, inner floral bract and flower. D, seed E, plant, natural size.

Specimens of this plant in fruit only were collected by Professor Osborn in the Casuarina forest on North Pearson Island in January, 1923. He was afterwards successful in growing it from seed at the Adelaide University, and at his suggestion it has been named in honour of Sir George Murray, K.C.M.G., LL.M., Chief Justice of South Australia, who assisted the expedition to the Pearson Islands by a generous donation.

It differs from most other described species of *Centrolepis* by the complete absence of scape, the floral bracts being sessile or almost so among the inner leaves, which are for the most part reduced to the enlarged sheath, one such sheath clasping the base of each pair of floral bracts and always on the side occupied by the inner or upper bract. In size it takes its place among the other small moss-like tufted species, but differs from *C. humillima*, F. v. M., by the 2 floral bracts, the absence of scales, and the large number of carpels; from *C. cephaloformis*, Reader, by the absence of scape, the awnless inner bract, and the solitary flower; from *C. muscoides*, Hieron., by the absence of scape, the awnless inner bract, the solitary flower, and the absence of scales; from *C.*

inconspicua, W. V. Fitzg., by the much shorter leaves and awns of the floral bracts, the solitary flower, the absence of scales, and the much more numerous carpels. The Pearson Islands lie about 40 miles off the western coast of Eyre Peninsula, but it is very possible that so minute a plant has been overlooked on the mainland.

CHENOPODIACEAE.

Kochia excavata, n. sp. Herbula perennis procumbens, foliis sericeo-villosis linearibus 8-10 mm. longis, perianthio fructifero 10-12 mm. diametro alam horizontalem saepe rubellam comprehendente glabro vel tomentello, tubo 3-4 mm. longo herbaceo circa medium constricto denique in basin latam excavatam ampliato.

Port Willunga northwards to Flinders Range; Murray lands. Also north-western Victoria. The type was collected at Spalding. The perianth-tube, constricted about the middle and then expanded downwards into a broad hollow base, renders the fruit of this species very distinct.

Var. **trichoptera,** n. var. Ramis saepius longioribus quam in typo, floribus in longas spicas aggregatis folia floralia fere occulentibus, perianthio fructifero 5-10 mm. diametro alam albo-tomentosam comprehendente, tubo tomentoso circa 2 mm. longo.

Dublin scrub to Flinders Range; Musgrave and Gawler Ranges; Murray lands. Also near Broken Hill in New South Wales. Differs considerably from the type in the inflorescence, but the perianth, although somewhat smaller, has the same shape.

Kochia tomentosa, (Moq.) F. v. M., var. **enchylaenoides,** n. var. Caule ramisque lanatis, foliis tomentosis 5-10 mm. longis; perianthio fructifero depresso-globoso demum nigrescente et eum *Enchylaenae tomentosae* simulante, summo tubo margine angusto cincto qui saepe in alam 1 mm. latam extenditur, perianthii lobis prebrevibus ciliatis. Varietas forsan potius pro specie distinguenda.

Near Charlotte Waters, coll. S. A. White. This variety differs from Queensland specimens of *K. tamariscina* (Lindl.) comb. nov. in the woolly more robust stems, the woolly and longer leaves, the flowers less crowded along the branches and in the perianth, whose lobes are minute and in the centre of the flattened summit; the perianth is also slightly beaked at one side by the protruding radicle, quite in the manner of *Enchylaena tomentosa.* In *K. tamariscina* the leaves are 2-5 mm. long and scantily pubescent, while the perianth-lobes are comparatively large and cover the summit of the perianth, which is not beaked.—*Suaeda tamariscina,* Lindl. (1848); *Enchylaena microphylla,* Moq. (1849); *Kochia microphylla,* (Moq.) F. v. M. (1874). The new variety should perhaps be distinguished as a species.

Bassia paradoxa, (R. Br.) F. v. M., var. **latifolia,** n. var. Variat foliis 15-25 mm. longis 5-8 mm. latis dense tomentosis, capitulis 15 mm. diametro, spinis (in exemplaribus nostris) ad 5 brevia cornua obtusa reductis.

Strzelecki Creek, near Innamincka, coll. S. A. White.

AMARANTACEAE.

Ptilotus Murrayi, F. v. M., var. **major,** n. var. Variat caulibus foliisque majoribus, foliis potius ovatis quam oblongis 8-15 mm. longis, spicis cylindricis 8-30 mm. longis, perianthio 3-4 mm. longo medio viridi vel flavescente.

Collected by R. Cockburn in the Far North-East, without exact locality.

Amarantus Mitchellii, Benth., var. **grandiflora,** n. var. Variat perianthii segmentis 5-6 mm. longis, exterioribus fere obovatis, fructu et semine majoribus. Forsan species nova.

Only known by one specimen in the Tate Herbarium, from Mount Parry, near Lake Torrens.

AIZOACEAE.

Trianthema crystallina, Vahl var. **clavata**, n. var. Variat foliis suculentis clavatis 6-10 mm. longis.

Far North and westward to Musgrave Range.

PORTULACACEAE

Calandrinia remota, n. sp. Species *C. polyandrae* habitu floribusque persimilis, stylis crassioribus basi breviter coalitis, staminibus oblongis, seminibus numerosis laevissimis nitentibus suborbicularibus colorem sucineum trahentibus ½-¾ mm. diametro.

Gawler Range; northern part of Flinders Range to Cooper's Creek. A Parakeelya near *C. polyandra*, (Hook.) Benth., and *C. balonnensis*, Lindl., but differs from all the other large-flowered species in its very smooth shining suborbicular amber-coloured seeds. *C. pleiopetala*, F. v. M., has also smooth seeds, but they are uniform and dark coloured, and the petals are narrow and 8 or 9 in number, while those of *C. remota* are 5 and obovate in shape.

CRUCIFERAE.

Hutchinsia eremaea, n. sp. Herba annua procumbens pilis bifurcis appressis pubescens, foliis radicalibus lyrato-pinnatifidis obtuse lobatis, superioribus oblanceolatis remote paucidentatis, sepalis 2 mm. longis, petalis paulo longioribus verisimiliter albis cum laminâ orbiculari, pedicellis fructiferis patenti-erectis 5-8 mm. longis, siliculâ ovatâ vel ovato-oblongâ 6-8 mm. longâ plus minusve pubescente apice parum alatâ et emarginatâ, stylo vix exserto, seminibus 3-6 in utroque locello ovoideis brunneis 2 mm. longis, cotyledonibus incumbentibus.

Murray lands; Nullarbor Plain. Also in the Grey Range, New South Wales.

LEGUMINOSAE.

Acacia calamifolia, Sweet, var. **euthycarpa**, n. var. Variat legumine fere directilineo laevi 7-11 cm. longo 6-7 mm. lato; funiculo semen duplici plicaturâ omnino cingente.

Southern districts; Yorke Peninsula; Kangaroo Island; Eyre Peninsula. *A. juncifolia*, Benth., has a somewhat similar pod and phyllodia, but the funicle is very different.

Acacia sclerophylla, Lindl., var **lissophylla**, n. var. Variat phyllodiis rigidissimis laevibus glaucis 15-25 mm. longis 3-4 mm. latis in parte superiore, nervis tantum sub lenticulâ visibilibus, mucrone saepius recurvo, pedunculis geminis 2-4 mm. longis.

Yorke Peninsula. A variety distinguished chiefly by its very hard, smooth phyllodia.

Indigofera longibractea, n. sp. Fruticulus pilis appressis griseo-tomentosus, foliolis 5-15 oblongo-cuneatis oppositis obtusis vel retusis 4-20 mm. longis, stipulis saepius spinescentibus, racemis folia superantibus, bracteis subulatis fusco-tomentosis 6 mm. longis alabastra excedentibus, calyce 6 mm. longo fusco-tomentoso, dentibus acuminatis aequilongis longioribus quam tubus, vexillo lilacino circa 10 mm. longo, ovario pubescente 6-12-ovulato, legumine ignoto.

Blood's Creek; near Musgrave Range; also in Central Australia. Appears to approach nearest to *I. brevidens*, Benth., but has bracts considerably longer than the buds, a longer and dark-haired calyx, with teeth of equal length and longer than the tube; the leaves are often much longer than in *I. brevidens*.

Acacia aneura, F. v. M., var **latifolia**, n. var. Variat phyllodiis lineari-lanceolatis subobtusis rigidis 4-7 mm. latis.

This broad-leaved variety is found in similar situations to the type; its phyllodia, like those of the narrow-leaved mulga, are always minutely pubescent.

Cassia Sturtii, R. Br., var. **involucrata**, n. var. Variat tomento crispo albo, foliolis 3-4-jugis obovatis 1½-2 cm. longis circa 10 mm. latis cum glandulâ inter utroque jugo inferiore, floribus 4-6 umbellatis involucro bractearum majuscularum obovatarum cinctis, unâ et alterâ antherâ longiore quam ceterae.

Birksgate Range, coll. R. Helms.

Pultenaea trinervis, n. sp. Frutex habitu ad *P. involucratam* accedens, foliis ovato-lanceolatis rigidis 8-15 mm. longis supra concavis glabris infra villosis trinervibus in mucronem fere pungentem desinentibus, petiolis circa 2 mm. longis, floribus in axillis ramulorum, calyce 4 mm. longo in lobis acuminatis pubescente stipulis involuto, bracteis nullis, bracteolis ovato-oblongis brunneis concavis sub calyce insertis, ovario villoso.

Mount Lofty Range; near Port Lincoln.

This plant was placed by Bentham under *P. villifera*, Sieb., as var. (?) *australis*, but Mr. H. B. Williamson, the monographer of the genus, agrees with me that it would be better to treat it as a distinct species. It appears to stand nearer to *P. involucrata*, Benth., than to *P. villifera*.

P. villifera, Sieb., var. **glabrescens**, n. var. Foliis fere planis latioribus 15-20 mm. longis 6-7 mm. latis in mucronem pungentem 2 mm. longum abeuntibus prope basin ciliatis cetera glabris, nervo medio infra conspicuo lateralibus minus claris, petiolo pubescente ½-1 mm. longo, calyce 5 mm. longo viscido, bracteolis lanceolatis.

Western River, Kangaroo Island. Coll. H. Griffith.

NOTES ON THE GEOLOGICAL FEATURES OF THE MEADOWS VALLEY.

By D. Mawson, Kt., D.Sc., F.R.S.

[Read October 11, 1923.]

Physiography.

Two valuable papers (1) have been written on the Geology and Physiography of the Meadows Valley by Dr. E. O. Teale.

The present contribution supplies some additional facts, more particularly relating to the vicinity of Blackfellow's Creek, which, though not a confluent of the Meadows Creek itself, is nevertheless embraced within the major boundaries of the Meadows Valley, namely, the Willunga Range and the Mount Magnificent Range. These latter ridges are remarkably accordant in height and are remnants of a former peneplanation. Between them is a broad shallow valley from five to six miles wide, with a floor at a level of about 1,000 feet above the sea and some 300 feet below the summit line of the ridges on either side.

Towards its northern end, between Wickham's Hill and Prospect Hill, is an unbroken depression. Here the rocks on either flank are steeply dipping quartzite and slaty beds of the Adelaide Series, whilst the central area is deeply silted up with horizontally bedded clayey and sandy strata of a more recent age.

Southward of this location, a central elevated block of "Barossian" gneissic rocks occupies much of the region between the limiting ranges. This block of ancient crystalline rocks is being dissected by three streams, all of which, to the south, enter the region of Permo-Carboniferous glacial sedimentation already described by Professor W. Howchin.(2) On its western margin is the Myponga Creek heading up from the south. On its eastern side Blackfellow's Creek is cutting its way along the junction of the "Barossian" and "Adelaide Series," also heading to the north. Both of these streams are of consequent type. The Meadows Creek itself flows southward over the soft sedimentary accumulation of the valley floor until meeting the "Barossian" rocks, through the tough body of which it flows without deflection. Thus the Meadows Creek occupies an inherited course. The toughness of the crystalline complex to the south limits the rate of downward erosion, which has resulted in the preservation of so much of the soft valley filling as still remains in its upper course. Had the flow of the Meadows Creek followed strictly consequent lines it would have been continuous with the Myponga Creek.

Dr. Teale reports (3) having found a glaciated boulder in a road cutting near Dingabledinga School, which is towards the southern end of the Meadows Valley. That discovery led him to suggest that possibly "the Meadows Valley may, in part, be a trough, the earliest features of which are due to glacial erosion in Permo-Carboniferous times."

As a result of numerous visits to that locality before Dr. Teale's paper was published, I had begun to suspect that the physiography was likely to be partly Permo-Carboniferous glacial, and the news of the discovery by Dr. Teale of an ice-scratched boulder did not come as a great surprise. Since then my attention has been directed by Mr. W. Durward, Chief Forester of the Government

(1) "The Physiography of the Meadows Valley," Trans. Roy. Soc. S. Austr., xlvi., 1922, p. 160. "Soil Survey and Forest Physiography of Kuitpo," Bulletin No. 6, Dept. of Forestry, University of Adelaide.

(2) "Description of a new and extensive area of Permo-Carboniferous Glacial Deposits in South Australia," Trans. Roy. Soc. S. Austr., xxxiv., 1910, p. 231.

(3) Trans. Roy. Soc. S. Austr., xlvi., 1922, p. 163.

Forest of Kuitpo, to the existence of two large boulders of granite in the forest area. These occur in Section 3419, Hundred of Kuitpo, approximately on the line of the cross-section between Wickham's Hill and Prospect Hill, and seven miles north-east of Dingabledinga.

As found, these granite boulders were about 2 feet and 2 feet 6 inches diameter respectively, and were not glaciated. In company with other smaller pebbles they had weathered out of a somewhat sandy surface formation. The locality is elevated a little above the floor of the valley on a low rise of soft sandy beds. The boulders are separated by a distance of about a quarter of a mile. They are both red in colour, due to the abundant development of red orthoclase felspar. In no essential feature do they differ, though one contains more biotite than the other. Other minerals present are quartz and a very little plagioclase. Strain features are noticeable in the microscope slide. The rocks have every appearance of being a slight modification of the typical red granite of the Murray River Valley. They are obviously erratics.

There are several areas in the Meadows Valley of a very sandy nature, notably Sections 216, 211, 209, 207, 206, and 205, which are all in a line leading to Peter's Creek. Samples of these surface sandy formations, when examined microscopically, were found to be constituted of water-worn grains. However, in the case of a very fine-grained argillaceous sandy bed entered in sinking a well on Sec. 3454, the particles were seen to be angular splinters, which is characteristic of glacial sands and muds. In the vicinity of Knott's Hill, at the head of Peter's Creek, the sandy formation is especially well developed and quite 50 feet in thickness in some places. Here waterworn boulders are so mixed up with it as to constitute a boulder wash in part, recalling the auriferous formation mapped as Tertiary at Mylor and other areas in the more northerly sections of the Mount Lofty Ranges. At this spot the Willunga Range scarp has been notched to a depth of about 200 feet below the general level of the old peneplain to which reference has been made. This is the only real break in the range between the Onkaparinga cut in the north and the seaward termination of the range to the south. Dashwood's Gully is a considerable scallop in the range caused by the headward erosion of its own creek, but at its head the level is still practically that of the old peneplain.

At Peter's Creek, however, the Meadows Valley may be entered at an elevation of little over 1,100 feet above sea level. By continuing down the Meadows Creek to the Finnis River, the Mount Lofty Range can then be crossed without rising to any greater height. This is the lowest passage available across the range, and is the natural route for trunk-line railway communication from one side to the other. This notch in the old peneplain, now occupied and in process of deepening by Peter's Creek, is inherited from an earlier system of drainage whereby the intermontane waters escaped to the west. The present creek is now continuing the work of an earlier cycle. Now that the glacio-fluvial character ot the old filling of the Meadows Valley appears well founded, it suggests itself that the notch at Peter's Creek may also be a remnant of old glacial topography. It is to be noted that the ice heading from Mount Compass in that direction would be leading towards Hallett's Cove, where is preserved the most northerly evidence of the Permo-Carboniferous glaciation yet known in southern South Australia.

Geological Cross-section.

In a traverse across the Meadows Valley from the crest of the Willunga Range, at a point about a mile south of McLeod's Hill, sandy and slaty beds, presumably lower members of the Adelaide Series, are met with on the western slopes of the valley. At the bottom of the slope in the neighbourhood of

Section 63, and elsewhere to the north and south, there appears a considerable thickness of a coarse felspathic sandstone of a rather crumbly nature. This resembles very closely the felspathic sandstone constituting the basal beds at Aldgate, though ilmenite is not a feature of it. Unfortunately its relation with the "Barossian" rocks forming the elevated block between the Meadows Creek and Blackfellow's Creek is obscured by a belt half a mile wide of old valley deposits, presumably in part a residual of Permo-Carboniferous glacio-fluvial sedimentation.

The "Barossian" rocks of the elevated block to which reference has just been made are mainly gneisses. On the eastern side, more or less along the line of Blackfellow's Creek itself, they are overlain unconformably by coarse ilmenite-bearing pebble beds and arkose which constitute the base of a thick series of slaty and calcareous beds and quartzite extending across the Mount Magnificent Range towards Strathalbyn. There seems to be no doubt that these beds are the lower members of the Adelaide Series. They were examined in detail as far as available outcrops would allow across the range to Bull's Creek.

The outcrop of the central "Barossian" massive opens out to the south and contracts to the north. No definite outcrop was observed north of Section 253 (Kuitpo), where it is well exposed in the creek bed near an old ruined homestead. The ilmenitic basal bed is seen on Section 3412. What features of the underlying strata are to be noted on Sections 246, 245, 251, 247, and 248 are indicative of the close proximity to the surface of the gneissic rocks over the area.

THE BAROSSIAN SERIES.

These oldest rocks have been referred to by Dr. E. O. Teale.[4] Where he noted fresh exposures of them they were observed to "consist mainly of siliceous schists, varying from quartz-schists to sericitic- and chloritic-quartz-schists, with some phyllitic-schist. They appear to be pegmatised in places, but fresh exposures are rare."

A more extended examination on the Blackfellow's Creek side has now revealed extensive areas of gneiss. On Section 90, they outcrop in a fresh enough state for microscopical examination. There the foliation planes strike N. 30° E. true and dip at 65° to the E.S.E. A very similar strike was noted to be a general feature of the formation over a wide area. Three specimens of gneiss collected at this locality have the following features:—

A coarse *Felspar-Quartz-Gneiss*. This is an aplitic type without mica and of coarse irregular texture. It consists principally of orthoclase, though quartz is also abundant. Scattered grains of plagioclase are present amongst the smaller material.

Even-grained, aplitic and perthitic, *Felspar-Quartz-Gneiss* from the creek bank near the mine shaft on Section 90. This is composed principally of an orthoclase-microcline perthite. Plagioclase, answering to oligoclase, is present in comparatively small amount, partly intergrown as perthite and partly free. The quartzes are mostly small and rounded, embedded in allotriomorphic felspars and present only in comparatively small quantity. The quartz shows strain features. A few grains of zircon and a little leucoxene are present.

Grey *Zircon-Syenite-Gneiss* from the main north-west to north-east trending tributary joining Blackfellow's Creek on Section 90. This is foliated in fine-grained bands, occasionally giving place to strings of a coarse texture in which felspar is prominent. Under the microscope the rock is seen to contain very abundant orthoclase, a little oligoclase and quartz in small quantity only. Biotite is distributed in very small fragments, and rarely distinct flakes of muscovite appear. There is, however, a considerable amount of fine sericitic

(4) Bull. No. 6, Dept. of Forestry, University of Adelaide, p. 7.

mica developed in the mash as a consequence of dynamic crushing. Some definite ilmenite is to be observed showing typical leucoxene change; also traces of hematite make their appearance sporadically. Small colourless zircons are easily discernible. This rock has evidently been a zircon-syenite which has been subjected to considerable dynamic force, and thereby suffered crushing and foliation. The ilmenite content is very distinct in the micro-slide, and as the basal bed of the sedimentary formation unconformably overlying it is rich in ilmenite grains, there appears to be every reason to couple the syenitic rock with the Houghton magma described by Benson[5] and to regard the sedimentary formation as the Adelaide Series.

Whilst referring to this magma, it is interesting to note that a dioritic form of the same was recently found by Mr. C. T. Madigan and myself to underlie the ilmenitic conglomerate at the Grey Spur, which locality is adjacent to the Inman Valley, about 20 miles to the south-west of the spot under present consideration. Dr. Benson has reported it at Houghton, Aldgate, Normanville, and, by inference, at Mount Compass. So that it is to be recognized as the dominant feature of the "Barossian" Series and the back-bone of the Mount Lofty Ranges.

THE ADELAIDE SERIES.

The beds lying unconformably above the gneisses of Blackfellow's Creek commence below as coarse arkose and pebble beds in which are chunks two and three inches in diameter of solid ilmenite. The felspathic ingredient has been much converted to sericite at the very base, but this change is less and less marked above. The coarse material is found only within 20 or 30 feet of the base, for it quickly passes upwards into a massive, fine-grained, felspathic quartz rock, with just a little mica appearing now and again and a faint ilmenite veining. In all, the beds of this character, exposed in this area, must reach 200 feet in thickness. On Sections 90 and 289 of Kuitpo this basal formation strikes N. 42° E. true and dips at 40° to the S.E.

The overlying beds, which are fortunately fairly regularly disposed, were examined along two lines of section as far as Bull's Creek. The bold ridge-line of the Mount Magnificent Range is outlined by a strong and thick quartzite horizon, the Mount Magnificent quartzite. Between the base of the series and this horizon, slaty beds with at least one thin quartzite band were encountered, but the outcrops were too poor for any connected description. In several places about a mile south of Prospect Hill, hard resistant nodules of the underlying formation of a sage-grey colour weathered out of the soil proved to be a tremolite rock. A study of the microscope section suggests that they probably represent metamorphose dolomitic sediments. The quartzite of the Mount Magnificent Range varies considerably in texture from bed to bed. Where most strongly developed it was noted to be even-grained and moderately fine in texture but felspathic.

On the down slopes to Bull's Creek, and overlying the above quartzite, more shaly beds were met. These pass into calcareous types above. On the line of section between Prospect Hill and Bull's Creek at its junction with Hamilton Springs Creek, a calcareous bar is met at the lower end of Section 3281, Hundred of Kondoparinga, and again more definitely at the junction with Hamilton Springs Creek. In that neighbourhood Bull's Creek evidently owes its location to the existence of this easily eroded line of strata; it is a consequent stream following a line of easy erosion. At this point on Bull's Creek is met a dove-grey marble composed almost entirely of calcite. There are also various gradations to less pure forms, in some of which brown biotite enters.

(5) Trans. Roy. Soc. S. Austr., xxxiii., 1909, p. 101.

These limestones were again noted on the slope further south outcropping on the Bull's Creek to Willunga Road. There they are considerably disturbed in strike.

In Section 3278, Kondoparinga, a bed of hard quartzite occurs and is quarried for road metal. In the same section also is a reef of barytes.

Throughout the area examined there was found to be a general agreement in strike of the beds on the west side of the Mount Magnificent Range, and also over a considerable portion of the eastern slopes. This general strike is approximately N. 40° E. true. In the vicinity of Bull's Creek itself, however, an approximate N. and S. trend prevailed.

The dip is consistently to the E., but more variable than the strike, though on the whole there is a general concordance ranging from 40° at the base of the series to 60° at Bull's Creek. The observations suggest a continuous series. Assuming this to be the case, and selecting the least disturbed areas and employing mean figures for the dip, the following thickness of strata is indicated:—From the base to the top of the Mount Magnificent quartzite a thickness of 5,000 feet. From this quartzite to the marble formation at the junction of Hamilton Springs and Bull's Creek another 3,800 feet is indicated.

IGNEOUS ROCKS OF THE MOUNT PAINTER BELT.

By D. Mawson, Kt., D.Sc., F.R.S.

[Read October 11, 1923.]

Plates XXXIII. and XXXIV.

As a result of two brief visits undertaken some years ago to the neighbourhood of Yudanamutana and Mount Painter, at the north-eastern extremity of the Flinders Range, a short note was published in the Proceedings of the Australasian Association for the Advancement of Science [1] defining a belt of Pre-Cambrian age in that portion of the State.

It was intended to follow up that investigation, but up to the present, owing principally to its remote situation, no opportunity has presented itself of revisiting the area. Nevertheless, the great importance of that locality both petrologically and mineralogically, calls for the publication of such notes as are already to hand.

The salient feature of the Mount Painter belt is the abundance of igneous rocks, in part normal igneous types, at other times metamorphosed to gneisses and schists. To a less extent metamorphic rocks of sedimentary origin are discernible in this complex.

General Features of the Central Zone.

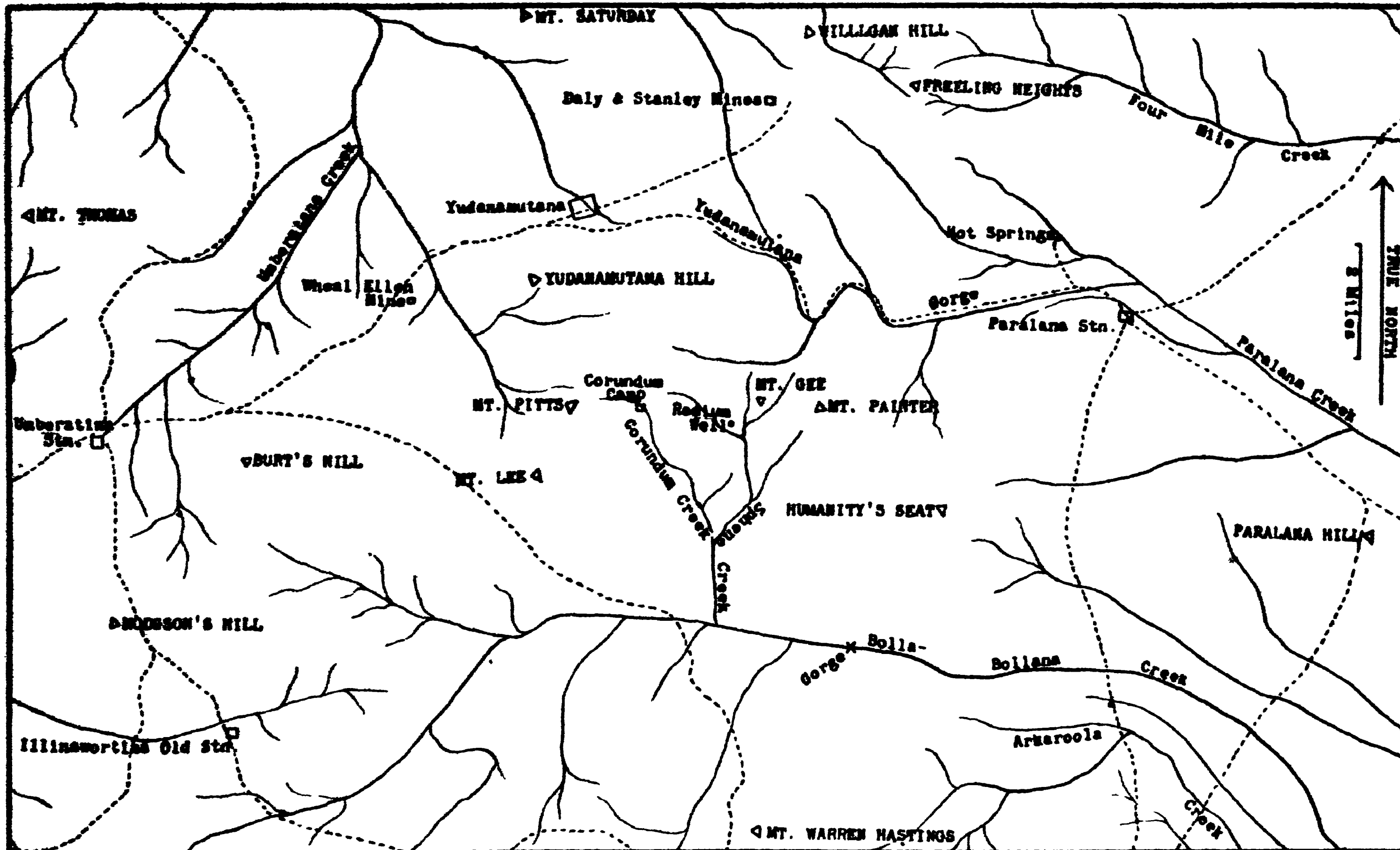
In the more central zone of this Pre-Cambrian belt, namely, in the neighbourhood of Mounts Pitts and Painter, the outcropping rocks are possibly more largely of igneous origin than in the outer region. Here are dense felsitic and granitic rocks recalling the Pre-Cambrian porphyry and granite of the Gawler Ranges and Moonta; also a considerable development of syenite-porphyry, quartz-felspar-porphyry, felspar-porphyry, and acidic gneisses sometimes exhibiting augen structure. Crossing both the igneous rocks and the included metamorphosed sediments are numerous pegmatite reefs, often composed of very coarsely crystalline quartz and red felspar, at other times consisting only of quartz. Pink and red felspars are a notable feature of the rocks of this portion of the field. Micaceous iron, ilmenite, sphene, and rutile are frequently observed to be present in notable quantities.

All these rocks have suffered metamorphism to some extent, others are very far changed, including both chemical reconstruction in the minerals themselves and mechanical crush.

Besides these obviously igneous forms, there is in this central belt scattered irregular patches of specially interesting schist formations,[2] notably corundum-mica-schist, pleonast-mica-schist, pleonast-tourmaline-mica-schist, cordierite-corundum-schist, cordierite-sillimanite-corundum-schist, cordierite-sillimanite-schist, etc. In certain localities these schists are notably rich in accessory tourmaline, monazite, and apatite. These remarkable patches of schist are frequently banded in such a manner as to suggest a former sedimentary origin, but they frequently merge into normal igneous rock. At the principal corundum-schist locality, that lying directly in the line between Mount Pitts and Mount Painter, the dominant rock neighbouring the schists is a quartz-felspar-muscovite-gneiss. Beyond the fact that pneumatolitic action with the introduction of certain

(1) Sydney Meeting, 1911, p. 118.

(2) "Mineral Notes," by D. Mawson, Proc. Roy. Soc. S. Austr., vol. xl., p. 262.



Map of the Mount Painter District, Northern Flinders Range.

ingredients from without and the depletion of silica is evidenced, we have no very definite explanation of these formations.

In other localities, still in the central belt, appear zones of weakness along which intense pneumatolitic and hydatogenous processes have been active. The great reef formation culminating in Mount Gee is the principal example of this kind. In this reef the most persistent constituents are quartz, often in drusy amethystine vughs, and specular iron.[3] At intervals other ingredients appear in notable quantities, including massive barytes, fluorspar (both green, blue, and black varieties), and uranium ores most commonly autunite and torbernite. On the eastern side of Mount Painter, in a continuation of the same mineralized zone, narrow veins of turquoise are associated with the uranium phosphate ores in a matrix consisting principally of micaceous and specular hematite and quartz. Several veins of stilbite, associated with fluorite, about 6 inches wide and of considerable horizontal extension, were found at the extremity of Mount Gee, extending outwards from the region of the lode formation across the igneous rocks, thus further attesting to the post-volcanic thermal character of the Mount Gee formation.

The common uranium minerals of this formation, namely, the autunite and torbernite, are found as flakes and scales in the more porous portions of the lode, often as a last mineral to crystallize in the vughs themselves. They are, therefore, amongst the latest minerals to be introduced. So far no quantity of uranium-bearing minerals of a more primary or magmatic character have yet been located, though in some areas of the lode and in the adjacent country monazite is quite abundant and may be uraniferous; also over a short distance in another locality the lode formation is studded with small crystals of brown fergussonite.

As regards the specific characters of the igneous rocks, unfortunately only a limited number[4] are available for microscopic examination.

Mount Gee to the Bolla-Bollana Gorge.[5]

The more acidic rocks of the central zone are in marked contrast to the prevailing basic types of the Bolla-Bollana Creek to the southward. As an exception, in the former case is a very coarse-grained, basic pegmatite outcropping about one mile south of Mount Gee in the small creek (Sphene Creek) leading therefrom to the Bolla-Bollana Creek. This pegmatite is constituted of coarse uralitic hornblende and clove-brown sphene, the individuals in each case often reaching 6 inches and more in length. Such a rock would appear to represent the pegmatite of a dioritic or gabbroic magma.

Passing down Sphene Creek sundry types of gneiss are traversed, some of which are clearly of sedimentary origin. Elsewhere, also, in the central belt of

(3) "Notes on some Occurrences of Silica near Mount Painter," Trans. Roy. Soc. S. Austr., xxxvi. (1912), p. 173.

(4) The major portion of the collection was rendered practically valueless by an accidental confusion of the specimens and their labels, which occurred during my subsequent absence abroad.

(5) In my earlier paper (Proc. Austr. Ass. Adv. Science, 1911, p. 118) this has been referred to as the Arkaroola Gorge. This confusion has arisen because in that paper I adopted W. B. Greenwood's geography of the locality. According to him, Sphene Creek junctions with the Arkaroola Creek, not the Bolla-Bollana Creek. On the most recent plan published by the Lands and Survey Department it is quite the reverse. It may be that the Government plan is in error, for Greenwood had an intimate knowledge of the country. In the meantime, however, it is safest to adopt the Government survey. As my notes are not detailed as regards the geography, I find a difficulty in accurately placing the gorge encountered in the great quartzite on the Bolla-Bollana Creek; so that the position marked with a cross on the plan herewith is but approximate.

Mount Painter rocks, the relics of sedimentary formations were noted, the more obvious being highly altered quartzite and boulder conglomerate.

On the track down Sphene Creek the more obvious gneisses are crushed igneous types, amongst which augen-gneiss figures. Igneous rocks which have suffered only minor metamorphic changes are also present, for instance, granite, sometimes porphyritic, is a feature, and in some phases its appearance recalls the Boolcoomata granite of the Olary district.

Two specimens of the more acid igneous rocks from this portion of the section from known localities are available for description.

The first is a *zircon-biotite-syenite* which forms a considerable outcrop in the creek about two miles below Mount Gee. In the hand specimen it appears as a light-grey rock in which large white felspars, frequently three-quarters of an inch in length, are the most conspicuous feature. A gneissic parallelism of these felspars is discernible. Between the porphyritic felspars is a fine-grained matrix of quartz, felspar, and reddish-brown mica.

The microscope section shows that the rock has undergone some crushing, the edges of the porphyritic individuals have been granulated, and the fine base material, which is of an allotriomorphic granular character, exhibits frequent inclusions of one mineral within the other to such a degree as to suggest recrystallization in part. The porphyritic felspars have the general characters of anorthoclase Elsewhere the felspars are represented by orthoclase microcline, acid plagioclase, and perthite. Quartz is plentiful but only in small individuals; it would appear to be insufficient in quantity to characterise the rock as a granite. Biotite is plentiful in very small fragments, strongly pleochroic from colourless to reddish-brown. Small grains and prisms of zircon are comparatively numerous. Grains and rods of apatite are rare. This rock seems best described as a zircon-biotite-syenite.

The second specimen, a somewhat altered *quartz-felspar-porphyry,* comes from an outcrop forming a bar in the creek bed about a mile below that just described. The hand specimen is a pink-coloured, dense rock in which are discernible small quartzes with a bluish opalescence and the outlines of numerous porphyritic felspars set in a felsitic base.

In section under the microscope the quartzes are seen to be badly strained. The felspars, which were apparently orthoclase, are largely changed to crystalline aggregates; some are quite indistinct relics. The base is constituted of fine felsitic granules. Grains of magnetite and some very tiny fragments and broken wedges of colourless sphene are also present as primary minerals. There are present also some very minute granules of honey-yellow to bottle-green colour which look like pistasite, but as they appear to be primary may be monazite. The ragged edges of the primary minerals indicate at least some degree of mashing. This rock was evidently originally a quartz-felspar-porphyry, but has undergone considerable metamorphic recrystallizations, without any marked dynamic alteration.

A specimen of a light-coloured, fresh-looking granite from amongst the collection made in the Mount Painter belt is worthy of reference, though its exact locality is wanting.

In the hand specimen it appears as an even-grained granular rock in which flesh-coloured felspars stand out amongst white felspars, quartz, and muscovite.

Microscopically the felspar is noted to be microcline, orthoclase, and an acid plagioclase. The latter, which is very near to albite, is rather abundant. Quartz is plentiful and muscovite plates numerous. The rock is very fresh, and appears to have been strained, but has not suffered crushing. The orthoclase felspars and the quartzes show shadowy extinction and the mica plates are bent. By reason of the abundance of plagioclase this rock tends towards the adamellites,

but on account of the albitic nature of the plagioclase and notable amount of muscovite the rock must be very rich in alkali, and as ferromagnesian minerals are absent, it can be regarded as an *Alaskite*.

At the junction of the Mount Gee Creek with the Bolla-Bollana Creek, basalt appears in the section. In this neighbourhood also the strata are cut by a quartz reef of gigantic proportions, continuing out of sight on either hand. Coarse-grained basic rocks, doleritic and gabbroic, outcrop at intervals beyond leading to the Bolla-Bollana Gorge, where the creek cuts through a great quartzite bed.

Just before reaching the great Bolla-Bollana Gorge quartzite formation, a specially notable area of basaltic igneous rocks was met with. Here some evidence of intrusion was observed, but other parts of the formation were brecciated in a manner which suggested a possible tuffaceous character. The metamorphism which these rocks have undergone obscures their features, and further investigation is needed before any more definite statement can be made. As much of the basalt was noted to be vesicular with amygdular fillings of a white secondary mineral, further support was given to the suggestion of an effusive origin.

Unfortunately no specimens of these basaltic rocks are preserved for microscopic examination. However, a series of vesicular basic rocks collected not far distant on Paralana Sheep Station by the late W. B. Greenwood,(8) and which have very similar features to those at the Bolla-Bollana Gorge, are available, and a description of them follows. It is assumed that they represent other outcrops of this same basic series of lavas elsewhere in the district.

A moderately coarse-grained amphibolitic rock collected from a large outcrop on the Bolla-Bollana Creek one and a half miles below the junction of the Mount Gee Creek has the following characters as noted in the microscope section:—

The predominant mineral is actinolitic hornblende in irregular elongated rectangular forms poikiloblastically enclosing minor constituents of the rock. These latter are biotite, muscovite, and calcite as small individuals. There is no definite schistose distribution of the ingredients, the individuals being arranged at all angles to each other. The texture of the rock is typically that of the crystalline schists. This rock, therefore, has arrived at its present condition either by the complete recrystallization of an original basic igneous rock or by the thermal metamorphism of calcareous beds. There is a considerable similarity in microscopic section between this and a certain actinolite rock associated with the copper ore deposit at Yudanamutana.

Vesicular Lavas from Paralana.

The vesicular basic rocks collected by Mr. Greenwood are *amygdaloidal melaphyres*, and comprise five specimens of one class and one of another. The largest member of the first group has the following characters. In the hard specimen it appears as an aphanitic, chocolate-brown rock studded with numerous irregular-shaped, pinkish patches of an amygdaloidal nature.

The microscope section reveals a basaltic texture modified by metamorphic changes which have almost completely reconstructed the mineral components. Relics of the former plagioclase laths are now somewhat dusty, due to change to fine, practically irresolvable aggregates, the principal constituent of which corresponds closely in character to albite. Apart from the areas actually occupied by the relic felspars, the whole section is thickly studded with opaque iron ore, originally magnetite, but partly gone over to limonite. Chlorite is present

(8) Mr. W. B. Greenwood was a capable and observant prospector with a good knowledge of the district. He rendered me much assistance on the occasion of my visits.

throughout the rocks in small and inconspicuous particles, and talc is quite abundant, often with numerous magnetite grains embedded in it. An original fine-grained ferromagnesian mineral and what appears to have been a glassy base, whose former presence is strongly suggested by the present textural features, have been transformed into iron oxide, chlorite (pennine), and talc.

The amygdular inclusions are constituted of faintly blue-green chlorite and a fine scaly mineral corresponding to talc. To a minor extent microscopic granules of quartz and calcite are present.

The original rock was evidently an amygdaloidal basalt, but as a consequence of great antiquity has suffered recrystallization. Except for the steam holes and their fillings this rock closely resembles in microscopic features the chloritised basalt described from the Blinman South Mine by W. N. Benson.[7]

The other four specimens of similar type to that just described vary only in minor details of structure and in quantities and modifications of the original minerals. They range from a chocolate-brown to a warm-grey colour, as noted in the hard specimen; also there is a noticeable variation in the quantity and character of the vesicles now filled by secondary minerals.

Judging by the development and distribution of the plagioclase laths, as seen in the microscope slide, the original structure probably ranged from true doleritic forms to pilotaxitic and to almost hyalopilitic types. There is some variation in the changes which affect the plagioclases, but rarely in any relic left of original twinning. The quantity and distribution of the iron ores is variable. Magnetite is partly in tiny original idiomorphic crystals and as a secondary dust. Plagioclase needles are noted to show flow structure around certain of the large magnetites. Limonite and hematite are much more abundant in some specimens than in others, and very much affect the prevailing colour of the rock. In all cases original pyroxene and glassy base have changed to chlorite, talc, and dusty iron ores. In one specimen occasional grains of yellow epidote are to be seen.

The vesicles are usually very irregular in form, and longish flattened ones are present up to three-quarters of an inch in length. In one case a crack extending over a considerable area in the specimen is also filled in the same manner as the vesicles. The usual filling of these is a pinkish peripheral layer of what is apparently quartz clouded with ferruginous dust. Within is a whiter area in which are variable proportions of granules of clear quartz, talc, chlorite (pennine), and much more abundant calcite, which usually occupies the central zone. In one rock only, grains of yellow epidote also appeared in the vesicles, and in another case chalcedony was noted.

The other class of amygdular melaphyre collected by Mr. Greenwod is of a striking appearance. It is an aphanitic grey rock packed with spherical white amygdules. Thus in its general appearance it recalls some leucitophyres.

In microscope section it is seen to be composed of recrystallized plagioclase needles in a base dusty with fine magnetite and composed largely of chlorite with low double refraction. There are also ramifying patches at intervals of a fine scaley mineral of high double refraction either talc or white mica. The original structure appears to have been hyalopilitic.

The amygdules are mainly filled with quartz in the form of elongated granules usually arranged in a rough sub-radial manner. The only other mineral of the vesicles is what is apparently white mica in aggregates of the most minute particles. This latter mineral is never present in quantity and is usually disposed peripherally.

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(7) Trans. Roy. Soc. S. Austr., xxxiii., 1909, p. 226.

Sedimentary Series at the Bolla-Bollana Gorge.

A great quartzite formation is cut across by the Bolla-Bollana Creek at the spot known as the Gorge. There the bed is roughly 500 feet thick and strikes N. 30° E. In places it shows evidence of folding, but for the most part dips steeply to the south [8] (about 60°). Beds of grit and pebbles are included, and in them the pebbles are chiefly quartz and quartzite, but there are also many dark coloured ones of basaltic appearance and light coloured felsitic types, some of which were noted to be epidotised.

The finer-grained section of this quartzite formation is ripple marked and shows fine current bedding features. There is present a small quota of oxide of iron in fine grains arranged in laminae, of which 60 major laminae were counted in 6 feet of the rock. Some of this original black iron sand has been converted to hematite and impart a slight reddish tinge to some areas of the rock.

Above this quartzite follow several hundred feet thick of beds ranging from a very fine-grained sandstone below, then shaley beds and finely calcareous slates. The relation of these beds to the quartzite below was not determined, as no clear contact came under notice, but it was assumed that they follow regularly above the quartzite.

Now follows a definite unconformity. A coarse conglomerate is seen in the creek dipping to the S.S.E. at a much lower angle than the underlying beds just described. Where weathered the sandy matrix has crumbled to a large extent, and the boulders show up well. These latter are rounded and subangular. No glacial striae were observed, but the time available gave no opportunity for making a proper search. Though not at all a typical tillite in character, this boulder rock, nevertheless, has certain characters which suggest a glacial or fluvio-glacial origin. This conglomerate formation constitutes what appears to be the base of an extensive series outcropping to the S.S.E. in low undulating hills. Unfortunately there was no opportunity for a reconnaissance in that direction. The general lithological features of the beds suggested, at the time, the Adelaide Series (Proterozoic) [9] as exposed widely in the North Flinders Range further to the west. This view is strengthened by the fact that, what appears to be a glacial tillite horizon higher up in this same series was reported by Mr. W. B. Greenwood [10] to cross the Arkaroola Creek a few miles lower down at a spot two miles east of the Kingsmill Mine.

Reverting to the detail of the conglomerate formation, boulders were noted near its base identical in character with the underlying shaley sandstone. Above, the great bulk of the boulders, especially the larger ones, are identical with the great quartzite in the gorge, for example, exhibiting the very striking regular fluting due to a characteristic arrangement of the iron sands under the influence of a flowing water. One of the boulders measured 3 feet 6 inches in diameter. Very few are more than 2 feet and most are but a few inches in diameter. Other types of rocks noted were a red-tinted quartzite, a dense gritty quartzite, and several large blocks of grit just like that at the base of the shales below. Many of the boulders were so far weathered as to be unrecognizable, though several suggested decayed felsites. Neither granitic nor basaltic rocks were recognised. Though the traverse probably did not reach the limits of the boulder bed, a thickness of fully 500 feet was recorded.

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(8) The field note-book says dipping "north," but this appears to be contradicted by later entries, and is therefore taken to be a clerical error.

(9) Sir Edgeworth David, Trans. Roy. Soc. S. Austr., xlvi., 1922, p. 6.

(10) Private communication.

Basic Intrusions at Yudanamutana.

Turning now to the north-western margin of the igneous and metamorphic complex forming the Mount Painter belt, there is, flanking it, in the neighbourhood of Yudanamutana, a massive quartzite formation extending far on either hand as the dominant feature in the physiographic relief. It passes just south and east of the township of Yudanamutana, and was noted to extend west to the vicinity of the Wheel Ellen Mine and east to the high land block known as Freeling Heights.

A splendid section is exposed in the gorge cut through it by the stream which leads from the township southward. In its broader features, this quartzite formation resembles the great quartzite of the Bolla-Bollana Gorge on the opposite side of the Mount Painter belt, but there are yet many points that need reconciling before their identity can be definitely asserted. The evidence is, however, strongly in favour of their identity, and, further, indicates that this quartzite and boulder bed (for in places beds of massed boulders appear in the formation) is the basal stage of a sedimentation cycle postdating the highly metamorphic intervening belt.

Along the outcrop to the south-west, in the vicinity of the Wheel Ellen Mine, a section of the beds passes down from tillite and certain other associated boulder beds in which practically all the boulders are quartzite, a formation which outcrops at Red Hill, through slaty beds which are in part calcareous and dolomitic to the quartzite and grit beds of the ridge at the Wheel Ellen Mine itself. This formation and some associated softer bands beneath it rest upon acid schistose and gneissic rocks, amongst which is a typical augen gneiss similar in general features to that well-known example near the south-west extremity of the main outcrop of the Broken Hill lode. In this area, below the quartzite, many quartzose reefs occur crossing the formations; these always contain much micaceous iron and ilmenite. The overlying beds have been considerably metamorphosed, for example, actinolite is noticeably developed in the quartzite and in calcareous beds higher up.

At Yudanamutana there is clear evidence of basic igneous activity postdating the great quartzite formation to which reference has just been made. Slaty and calcareous rocks overlying the quartzite are intruded by doleritic basic rocks with the accompaniment of considerable metamorphism producing hornstones and spotted schists, and causing the development of tremolite and actinolite in the more calcareous and dolomitic bands, which also are the matrices for the main depositions of copper ores formerly mined in this locality. It is interesting to note that some fine specimens of massive scheelite were got in association with the copper ores in actinolite rock at the smelter site. The copper was obviously introduced in association with the basic igneous rock.

The ore depositions are as irregular patches both in the intruded rocks and in phases of the igneous rock itself. The principal primary minerals thus represented are iron and copper pyrites and micaceous hematite. A pinnacled outcrop to the north of the township known as the Cockscomb is constituted of several large, parallel ferriferous reefs of this kind. There they are principally micaceous iron and jasperoid rock with some vesicular gossan, the latter indicating a weathered and removed pyritic content.

A specimen of an altered *diabase* from an intrusion at Yudanamutana has the following characters:—The hard specimen appears as a dense faintly greenish, dark-grey rock in which no porphyritic constituents are visible. Under the microscope a definite doleritic intersertal structure is preserved by the plagioclases which are still clear, but carry abundant inclusions of actinolite rods, minute biotite flakes, and grains of magnetite. The section is loaded with bundles of secondary diablastic actinolite.

The Western Foothills of Freeling Heights.

Freeling Heights, a splendid example of an elevated peneplane, stands out to the north-east from Yudanamutana. On the low country near its south-western extremity is the Daley Mine and other copper mines also associated with areas of basic rock intrusive into the upper sedimentary series. Again there is associated with the sulphides a great deal of micaceous iron. The intruded rocks include a remarkable develpoment of actinolite rock and spotted slates in which tremolite is seen to be forming at scattered centres, crystallizing in radial-fibrous forms. Some of the intrusive rock is slightly vesicular.

These intrusions at the Daley Mine are into slaty and calcareous beds, which by their relations to a tillite formation further to the north-east are evidently the Flinders Range equivalent of some part of the Adelaide Series

At a lower horizon, in the Waterfall Gorge, an extensive and very massive quartzite series is located. This appears to be a continuation of the gorge quartzite of Yudanamutana. Its dip varies a little and it appears to stand conformably upon metamorphosed calcareous sediments passing downwards into more slaty beds, and finally into conglomerate at the base.

This conglomerate, where examined, was found to be dipping steeply to the S.S.W. The boulders in it, which are rolled out and rendered schistose by pressure, are cemented by a matrix rich in grains of ilmenite and magnetite of original sedimentary origin. Occasionally entire bands of such fine ilmenitic sands traverse the conglomerate. Included blocks of quartz-porphyry are abundant in this conglomerate. A notable feature of this porphyry is that the quartz phenocrysts exhibit a characteristic blue tint. Many of the quartz grains in the matrix of the conglomerate are also of this kind.

Below the conglomerate are further beds of a slaty and sandy nature, and gravel rock rich in ilmenitic sands and blue quartz particles.

As a continuation of these beds, at a point somewhat further to the north again, on the flanks of Freeling Heights, is a massive sedimentary formation consisting of quartzites carrying bluish-tinted quartzes and large boulders of quartzite and of quartz-porphyry in which the quartzes show the blue tint.

An area of massive blue-quartz quartz-porphyry, much schistified, was met with near Willigan Hill. This is evidently a portion of the basement rock upon which the great sedimentary series was laid down.

All the beds thereabouts are in an advanced stage of dynamometamorphism and, in addition, thermal-metamorphism is evidenced to a considerable degree, often making it very difficult to delineate their original characters. It is, nevertheless, quite clear that in the neighbourhood of Freeling Heights there is a great basal series of conglomeratic and quartzitic rocks rich in ilmenite and capping unconformably an older terrain remarkable for the presence of extensive quartz-felspar-porphyry in which the quartzes have a characteristic blue tint. In this latter feature there is a resemblance to the quartzes of the Encounter Bay granite, though the intensity of blue colouration is often greater in the Mount Painter rocks.

Two different types of igneous rock were noted intruding this great basal sedimentary series near Freeling Heights—one a large basic intrusion, the other a dyke of reddish-brown coloured acid porphyry, macroscopically resembling a type that has been met with in the Flinders Range Tillite at Mueller's Hill.

A specimen of *quartz-felspar-porphyry* from the creek one mile north of the Willigan Hill Mine shows rounded, porphyritic bluish quartzes and the outlines of porphyritic felspars embedded in an aphanitic grey base. The microscope slide reveals that the quartzes are corroded and show pressure cracks and undulatory strain extinctions. The relics of porphyritic felspars appear in aggregates of secondary minerals. Relic structures in some of the felspars suggest

an original cross-hatch twinning, indicating that some of the original felspar phenocrysts were microcline, though indeed such a feature may be developed in orthoclase under stress. The base material is granulitic, and so fine grained as to be difficult to resolve, though small scraps of biotite are easily discernible throughout. The rock was originally a quartz-felspar porphyry with felsitic base.

A second specimen from the vicinity of Willigan Hill is a more severely altered form of the same rock. The eyes of blue quartz stand out clearly, but the base and the felspars have been granulated to such a degree that the rock is distinctly a schist, in which minute scales of dark mica figure prominently, imparting a dark colour and micaceous appearance to the entire rock.

Two erratics of an almost identical *quartz-felspar-porphyry* were found during the same expedition in the tillite at Red Hill.

In the hard specimen these are light-grey rocks of a microcrystalline character, with the exception of porphyritic quartzes and felspars. The quartz phenocrysts are smaller than usual in the Mount Painter Belt porphyries, and in one of the specimens are comparatively scarce. They exhibit merely a suggestion of the blue optical effect which characterises the closely similar rocks of the Willigan Hill neighbourhood. Relics of orthoclase and microcline phenocrysts are numerous in both specimens, all recrystallized as dusty aggregates. The base is a very fine-grained granular mass composed of clear granules like quartz with a sprinkling of biotite and a little muscovite. Strain features are shown by the porphyritic quartzes. The close correspondence between the rock of these erratics and that described above, collected *in situ*, makes it practically certain that they originated from the neighbourhood of Freeling Heights.

THE ACIDIC PNEUMATOLITIC AND HYDATOGENOUS INTRUSION OF THE GIANT'S HEAD AND TOURMALINE HILL NEAR UMBERATANA.

Though removed some few miles from the Mount Painter Belt proper, there is a very remarkable and abnormal intrusion extending at least for a very considerable length at no great distance from the road leading from Umberatana to Yudanamutana. It has a general west to east extension. The Giant's Head, near to and approximately south-east of Umberatana Head Station, is the western extremity of the formation. According to Mr. W. B. Greenwood, to whom reference has already been made, the intrusion continues to the eastward practically without a break until it merges into the Mount Painter complex. There was no opportunity of checking this statement. When examined at the Giant's Head, the intruded rocks of the Adelaide Series, not far below the tillite, are arched up and metamorphosed for a distance of a quarter of a mile from the contact. The metamorphic rocks thus produced are chiastolite schist, actinolite schist, tremolite schist, and silicated limestone. Also a little copper pyrites associated with haematite was noted in dolomite in the vicinity At this point the dyke has a width varying from 25 to 80 yards. The rock has all the characteristics of a low-temperature formation rich in gaseous and volatile components. It was from a patch in this formation that a fetid felspar was collected by Mr. Howchin and described by the present writer.(11) Striking formations of graphic quartz and felspar and graphic tourmaline and quartz are to be seen. In some areas where the rock is composed of granular quartz and felspar it is of a quite porous nature, and it is in just such places the quartzes and felspars are most notably charged with liquid inclusions, a constituent of which included matter is hydrogen sulphide, which imparts the fetid character to the rock. A coarse-textured pegmatitic formation cuts across the formation in one place and carries crystals of sphene noted up to 6 inches in length.

(11) Trans. Roy. Soc. S. Austr., xxx., 1906, p. 67.

A specimen of the more typical rock from the Giant's Head is even-granular and of aplitic appearance. It is composed of much microline, some orthoclase, and a smaller percentage of albitic plagioclase, together with a little muscovite. Dark-coloured tourmaline is distributed sporadically.

A second locality visited on the line of this intrusion was Tourmaline Hill, which is half-way between Umberatana Head Station and the Wheel Ellen Mine. Here the rock was seen to be closely related to that of the Giant's Head, but particularly rich in tourmaline. Patches of black tourmaline in quartz and tourmaline in a quartz-felspar rock were noted. In several places there were crystals of a light-green transparent tourmaline. Also large red garnets enclosing poecilitically much quartz and felspar.

In microscope section the composition of a specimen from this locality is seen to be microcline (probably a soda-microcline), a little orthoclase, notable plagioclase (apparently albite), quartz, a little muscovite and tourmaline. An interesting case was noted of a growth of microcline around a large plagioclase (albite).

The magma of this intrusion was evidently not at all a normal one, but rather of a pneumatolitic or hydatogenous character.

Summary.

1. In the great sedimentary series west of Yudanamutana, glacial tillite [12] of a very definite character with ice-scratched boulders has been met with at Mount Rose, Mueller's Hill, and Red Hill. This feature, taken together with the general lithological character of the beds, fixes their age as Adelaidean, formerly regarded as Lower Cambrian, but recently shown to be more probably Proterozoic. Conglomerate and quartzite beds near the base of this series in the Yudanamutana district have the ilmenitic facies distinctive of the basal beds of the Adelaide Series.

2. Still older rocks, largely igneous in origin and mainly acidic, occupy a belt surrounding Mount Painter, and flanked on either side by the Adelaidean formation. Included are highly metamorphic types which contain elements recalling the Barossian Series of the Mount Lofty Ranges and the Willyama Series of the Barrier Ranges and the Boolcoomatta Hills. In the light of present knowledge, the Mount Painter Belt should therefore be classed with these, and it is to be considered of early or middle Pre-Cambrian age. Certain features noted at Bolla-Bollana Creek and near Willigan Hill suggest that there may be represented two formations older than the Adelaidean beds.

3. Igneous activity is indicated of either two or three ages. Firstly, an early acid series, including the blue-quartz quart-porphyry shed as boulders in the conglomeratic rock close to Freeling Heights. Secondly, an acid phase, including the pink-coloured quartz-felspar-porphyry intruded into the boulder bed just referred to in the Freeling Heights area; also the aplitic and pegmatitic intrusion at the Giant's Head. Thirdly, a great basic series intrusive into the Adelaidean rocks in the Yudanamutana district and on the Paralana side of the ranges. It is quite possible that this third series is contemporaneous with the second acid phase. The association of some acid aplite and a quartz-ceratophyre with the basic intrusives of the Mount Remarkable area [13] is further support to this contention.

These basic intrusives are very similar to those already described [14] by

(12) First recorded in this area by Professor W. Howchin.

(13) "Petrographical Notes on the Igneous Rocks of Mount Remarkable," by Dr. E. O. Thiele, Proc. Roy. Soc. S. Austr., xl., 1916, p. 580.

(14) Proc. Austr. Ass. Adv. Science, xi., 1907, p. 418; also Proc. Roy. Soc. S. Austr., xl., 1916, p. 563.

Professor W. Howchin intruding the Adelaide Series at Blinman further to the south, and at Mount Remarkable, near the head of Spencer's Gulf. There is every reason to regard all these as of the same age. The fact that a basic dyke has been noted,[15] not far from Blinman, intersecting the fossiliferous Cambrian strata, suggests that these basic rocks are either late Cambrian or post-Cambrian in age.

4. The ancient vesicular basic rocks from Paralana have all the appearance of surface lavas, and in the absence of definite information are taken to belong to the same period of activity as instanced at Yudanamutana and Blinman. Neck-like forms of intrusion of vesicular basic rocks have been described already from Blinman These eruptions were possibly contemporaneous with lavas, agglomerate and tuff of diabasic character associated with the Victorian Heathcotian formation, which has been shown by Professor E. W. Skeats to lie at the base of the Ordovician formation.

DESCRIPTION OF PLATES XXXIII AND XXXIV

PLATE XXXIII

Fig 1 Traversing the lower beds of the "Adelaide Series" just before entering the township of Yudanamutana The jagged peaks in the distance are at the back of the town along the northern boundary of the rugged Mount Painter Belt The area of basic intrusions is within the view on the near side of the peaked ranges

Fig 2 In the Yudanamutana Gorge where it intersects the great quartzite formation; the latter apparently the basal member of the Adelaide Series in this vicinity

PLATE XXXIV

Fig 1 The rugged Mount Painter Belt looking north from a point on the western extremity of the Mount Gee lode

Fig. 2 Looking east to the elevated summit of Mount Painter itself Taken from a point on the Mount Gee lode some hundreds of feet above the adjacent valley floor The lode formation occupies the foreground

(All photographs by D Mawson)

(15) "A Geological Traverse of the Flinders Range from the Parachilna Gorge to the Lake Frome Plains," by Prof. W. Howchin, Proc. Roy. Soc. S. Austr., xlvi., 1922, p. 46.

ON SOME HALOPHYTIC AND NON-HALOPHYTIC PLANT COMMUNITIES IN ARID SOUTH AUSTRALIA.

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[Read October 11, 1923.]

Plates XXXV. and XXXVI.

The present paper is in the nature of a sequel to one published earlier this year, "On the Zonation of the Vegetation in the Port Wakefield District."(1) Some time must elapse before we can present our observations on the ecology of the arid North-eastern portion of South Australia owing to the size of the area to be examined and the necessity of visiting portions at different seasons of the year. It seems useful, however, to publish some of our data on the halophytic and non-halophytic plant communities in the district since the extent of the former has not been clearly understood. We desire to express our thanks to Lisle G. Johnson, Esq., owner of Dilkera; to Hamilton-Wilcox Limited, owners of Koonamore; to the Managing Director (A. G. Rymill, Esq.) of the Canowie Pastoral Company, owners of Curnamona; and to their Managers, Mr. J. P. Henderson at Koonamore and Mr. L. Boothby at Curnamona. All of these have materially helped us in our investigations by providing accommodation, transport, etc., besides many kindnesses. Without their aid it would have been impossible to undertake the work.

Introductory.

In the paper previously referred to we have given an account of the zonation of plant communities when passing from a littoral mangrove formation to a "saltbush" area. We showed that the sequence of communities might be correlated with a progressive decrease in both the soluble salts (whether "total" or "chlorides") and in soil moisture. A deduction was that "saltbush" (a dwarf shrubland of *Atriplex* spp.) is a community of arid conditions and is not halophytic. In the present paper we extend our observations to the typical saltbush country of the pastoralist, and give some of the evidence we have collected as to its essentially arid and non-halophytic nature. Huge areas in South Australia are occupied by a number of plant communities that have this in common—the abundance of dwarf shrubs belonging to genera of the Chenopodiaceae, especially *Atriplex* and *Kochia*. The former are popularly termed "saltbushes," because of their appreciably salt taste, the latter "bluebushes" because of the blue-white colour of the foliage owing to its covering of close cottony or woolly hairs. The abundance of these bushes gives a character to much of the arid and semi-arid portions of South Australia.

Saltbush has been very inadequately treated in the literature on Australian ecology and even ignored in the vegetation maps that have appeared. The North-east District of South Australia lying east of the Flinders Range from the Murray Basin to Lake Frome is about 25,000 square miles. Saltbushes or bluebushes are the character plants of much of this area, yet the names do not appear on either Diels' map of the vegetation of Australia(2) or Griffith Taylor's modification of it(3) published more recently.

(1) Osborn, T. G. B., and Wood, J. G., Trans. Roy. Soc. S. Austr., xlvii., p. 244, 1923.

(2) Diels, L., Die Pflanzenwelt von West Australien, Liepzig, 1906.

(3) Taylor, Griffith T., Australian Environment, Commonwealth Adv. Counc. Sci. and Indus., Mem. No. 1, p. 27, 1918.

West of the Flinders Range is an even larger district extending westwards to the Western Australian boundary, and occupied to a great extent by saltbush or bluebush. Both these areas are mapped as "Savannah," the feature of which is said to be that "much grass" exists. It is true that after suitable rainfalls the area is heavily grassed, but an overwhelming proportion of the grasses are therophytes, and as such give no permanent character to the flora.

The first sketch of the vegetation of South Australia was given by Schomburgk in 1876.[4] He refers to a "grass land" region in which are "gravelly and waterless flats" whose surface is "often saline . . . supporting only a scanty herbage of *Atriplex, Kochia, Salicornia,* and *Salsola.*" The association of Salicornias (now *Arthrocnemon* spp.) with *Atriplex* and *Kochia* may have given rise to the idea, expressed by later writers, that the two last were also halophytes. Schimper's[5] account is based largely on Schomburgk. Warming's[5a] references to arid Australia are also meagre. There is a general statement that salt lands occur in the central parts of many countries having a "continental" climate, including Australia. He makes no mention of *Atriplex* or *Kochia* shrubland, when describing "shrub steppe" vegetation (p. 281). The account in Diels' introductory section on the vegetation of Australia as a whole is more complete. Diels[6] does not specially describe the saltbush or bluebush communities of Western Australia. Describing the "desert" (Wusten) he pointed out that extensive areas without vegetation are not a feature of Australia. There is an arid type of flora with considerable diversity. He distinguishes loamy from sandy "deserts." On the former succulent-leaved Chenopodiaceous plants are the most general. Some types occur in saline depressions, *e.g.*, around Lake Torrens, but others grow freely on the drier "savannah" lands. Discussing the Chenopodiaceae later in the work,[7] Diels very pertinently asks if the occurrence of Chenopodiaceae always indicates richness of the soil in sodium chloride. He notes that certain species are prominent in littoral communities. *Atriplex paludosum* and others grow in salt swamps, while the almost arborescent *A. isatidea* occurs on stable dune thickets. "All these are naturally halophytes. On the other hand, it is less sure whether the Chenopodiaceae of the interior are also halophytes. In many cases this is at present uncertain; they occur like members of the Frankeniaceae around the margin of wide valleys that are covered with salt owing to erosion. Other species, however, occur only in stony loam, the salinity of which is not accurately known." Such are the Kochias, numerous Bassias, and "very conspicuous because of their size are the half shrubby *Atriplex* spp. and *Chenopodium* spp., the so-called 'saltbushes' of the pastoralists."

In Cannon's[8] description of arid South Australia the Chenopodiaceous communities, with the possible exception of bluebush, *Kochia sedifolia,* are regarded as halophytic.

Adamson and Osborn,[9] in their paper "On the Ecology of the Ooldea District," regarded communities of *Atriplex vesicarium* and *Kochia sedifolia* as non-halophytic. This opinion was based in part as a result of observations on the zonation of the vegetation around a gypsum salt lake in that district.

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(4) Schomburgk, R., "The Flora of South Australia," in Harcus, "South Australia," London, 1876, p. 217.

(5) Schimper, A. F. W., "Plant Geography," Oxford, 1903, p. 504.

(5a) Warming, E., "Œcology of Plants," Oxford, 1909, pp. 218, 234.

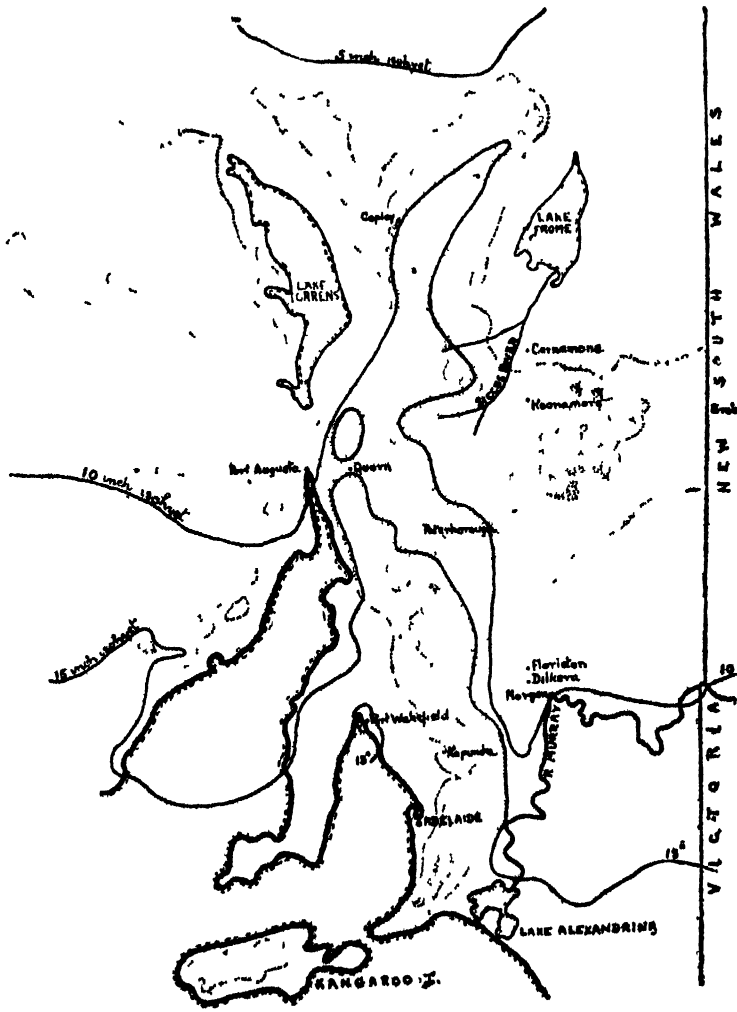
(6) Diels, *loc. cit.*

(7) Diels, *loc. cit.*, p. 274.

(8) Cannon, W. A., 1921, "Plant Habits and Habitat in the arid portion of South Australia," Carnegie Inst., Washington, Pub. No. 308.

(9) Adamson, R. S., and Osborn, T. G. B., Trans. Roy. Soc. S. Austr., vol. xlvi., p. 539, 1922.

Collins [10] describes the saltbush and bluebush communities of the Barrier Range District, New South Wales. These are developed on plains of "both sandy and alluvial soils, as well as in depressions which undoubtedly possess a certain percentage of salts." The conclusion reached is that the weight of evidence is in favour of the view that the master factor in their distribution is climatic rather than the edaphic one of soil salinity.



Text fig. 1.

Map of portion of South Australia showing contour lines of 500 and 1,000 feet, land over 1,000 feet stippled 5-, 10-, and 15-inch isohyets are shown, but not rainfall lines for higher precipitation.
(Based on a map published by the Geological Survey of South Australia, 1917.)

Topographic.

The communities dealt with in this paper have been observed over a tract of country running nearly 200 miles in a south-north line, from the River Murray to Lake Frome (text fig. 1). From the Murray Basin the district extends northward

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(10) Collins, M. I., "Studies in the Vegetation of Arid and Semi-arid New South Wales": Part 1, The Plant Ecology of the Barrier District, Proc. Roy. Soc., Linn. Soc. N.S. Wales, vol. xlviii.; Part 3, 1923, p. 229.

as a great plain rising gradually to an eastern extension of the Central South Australian highlands, which serves as the watershed between the Murray River and the inland drainage to Lake Frome. These highlands are of comparatively recent formation, geologically speaking, though composed of Cambrian rocks.(11) The ancient river systems have been cut across by the uplift forming these highlands, the altitude of which does not exceed 2,000 feet. Northward the land gradually falls again to Lake Frome. Much of the highlands have undergone peneplaination, and consist of wide flat valleys between low hills.

The rivers of the district are ill-defined and erratic in their direction of flow. They are mere watercourses running only at intervals in times of flood. They may be dry for years together and then come down in flood, overflowing their banks and temporarily submerging the surrounding country for as much as a mile or more on each side of the channel. Such watercourses have frequently no opening to the Murray or to Lake Frome, but terminate on a flood plain in a lake or swamp. Lake Frome itself is only a large example of this type. These centres of inland drainage serve as evaporating pans and accumulate a high percentage of soluble salts (see table of analyses).

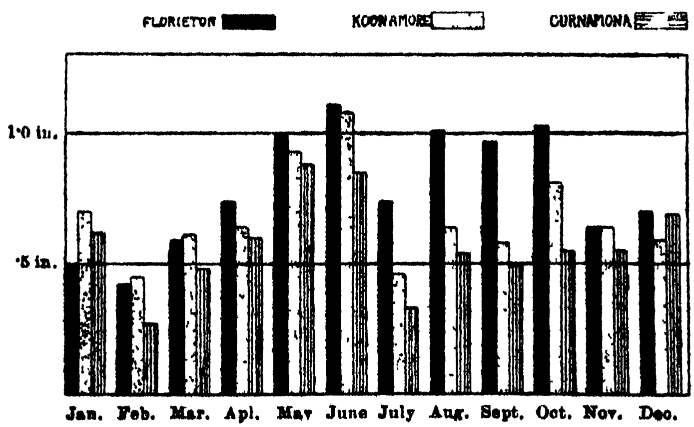
Climate.

Rainfall.—The area lies wholly within the 10-inch isohyet. The rainfall records of Florieton, near Dilkera Murray Basin, Koonamore, and Curnamona are given below:—

Mean Monthly Rainfall in inches.

Locality	Period of Years	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Mean for Year	Average Annual
Florieton	27	·49	·42	·59	·74	·99	1·11	·74	1·01	·97	1·03	·64	·70	9·48	9·97
Koonamore	27	·70	·45	·61	·64	·93	1·08	·46	·63	·58	·81	·64	·59	8·18	8·46
Curnamona	30	·62	·27	·48	·60	·88	·85	·33	·54	·49	·55	·55	·69	6·85	7·03

These results are shown graphically in fig. 2 Mean figures may be misleading, because in any single year there may be rainless or almost rainless months, while in others, of course, the fall may be considerably more than the mean. This applies especially to the northern stations.



Text fig. 2.

Diagram comparing the mean monthly rainfalls at Florieton (River Murray Basin), Koonamore, and Curnamona.

(11) Howchin, W., "The Evolution of the Physiographical Features of South Australia," Rept. Austr. Ass. Adv. Sci., xiv., p. 148, 1914.

Temperatures.—No detailed temperature data are available. The summer shade maxima are known to be often over 100° F. A surprising feature is the amount of frost in winter, particularly in the wide, flat valleys of the peneplain.

Other factors, such as wind and insolation, all increase the aridity of the environment. The relation of these to transpiration is described by Wood[12] in an account of some experiments conducted at Dilkera.

EDAPHIC FACTORS.

In a region without any striking variation of physiographic features, and showing little abrupt discontinuity in its climatic factors, the edaphic factors are of great importance in determining differences in vegetation. Even these factors are remarkably uniform over great distances. The great depth of soil found on the plains of this region is a feature similar to that observed in many other arid regions. Wind sorting is one of the factors responsible for the production of different soil types. As a result of its action there are produced sand ridges alternating with flats of finer-grained soil. These occur on a huge scale towards Lake Frome, where the alternation of sand ridges colonized by *Casuarina lepidophloia* with saltbush covered flats gives a distinctive stamp to the landscape. This is popularly called "black oak ridge country." On a smaller scale a similar result may be observed by lakes or swamps which frequently have a sand ridge in proximity to the bed of the lake. The relatively rapid change in soil type observable here is accompanied by an instructive change in vegetation (*c.f.* soil samples Nos. 13-15).

In this paper a selection of 15 of our soil analyses is given. These samples are chosen either to show the change in edaphic conditions when passing from a halophytic community to saltbush, or to show the essential similarity of soils over the whole saltbush area. This last feature applies to the series 1-6. As No. 5 we have repeated for purposes of comparison our analysis of the soil supporting a saltbush community at Port Wakefield, which lies outside the area under immediate discussion.

Methods.—The soil samples were collected with the aid of a sampling tool. Except where otherwise stated, cylinders of soil were taken from the first 9 inches of ground. The samples were placed in air-tight tins for conveyance to the laboratory, where the procedure was as outlined in our previous paper.[13]

The first column of the accompanying table of soil analyses gives the percentage of water present in the wet soil and is a measure of the water relation existing in the soil at the time of collecting. The columns for water in the dry soil and for saturation water run parallel to one another, *e.g.*, the sandy soils 14 and 15 with low saturation water show low water content in the air dry soil, saltbush soils have a saturation percentage of about 36 per cent., and the effect of clay in the lake soil No. 8 is reflected in the high saturation (41 3 per cent.) and the high water retaining capacity of air dried soil (8 8 per cent. of water). The saturation water was determined as described by us in our paper on the Port Wakefield soils,[14] but in this case the tubes were allowed to stand in water until a constant increase was observed due to the absorption of water. This constant increase is, as a matter of fact, attained almost immediately the water reaches the top of the soil column.

The soluble salts were determined, as in our previous work, by shaking 25 grms. of soil with 250 c.c. of water at intervals over 24 hours at constant

(12) Wood, J. G., Trans. Roy. Soc. S. Austr., vol. xlvii., p. 259, 1923.

(13) Osborn, T. G. B., and Wood, J. G., *loc. cit.*, 1923.

(14) Osborn, T. G. B., and Wood, J. G., *loc. cit.*

No.	Plant Community	Locality	Water at 110° C in wet soil, p. c.	Water at 110° C. in air-dry soil, p. c.	Water at Saturation, p. c.	Total Soluble Salts, p. c	Chlorine, p. c.	Sodium Chloride, p c.	Loss on ignition p. c.	pH.	Notes on structure of soil, p. c.	Remarks
1	*Atriplex vesicarium* dwarf shrubland	Koonamore (Alderman's)	8·7	3·3	38·5	·10	·03	·05	2·9	7·6	Fine quartz sand	
2	*Atriplex vesicarium* dwarf shrubland	Dilkera	7·1	5·0	38·8	·18	·04	·06	2·7	7·7	Do.	
3	Mallee with *A. vesicarium* ..	Koonamore (Johnson's)	3·7	2·9	35·5	·18	·03	·05	3·1	7·7	Do.	
4	Mallee with *A. vesicarium* and *Kochia sedifolia*	Dilkera	—	3·0	37·5	·14	·02	·03	2·8	7·7	Do.	
5	*Atriplex stipitatum*	Pt Wakefield	2·5	2·5	36·3	·30	·01	·02	2·3	7·4	Coarse quartz sand	Percentage of total salts while low is higher than for typical *A. vesicarium*
6	*Kochia planifolia* dwarf shrubland	Curnamona	—	3·5	32·6	·08	·01	·02	—	7·6	Fine quartz sand	
7	*Pachycornia tenuis*	Koonamore Nillinghoo Lake	15·6	4·0	29·5	6·60	2·14	3·52	1·8	8·2	Medium coarse quartz sand	This is a different type of lake from Nos. 8, 9, 10-12. In this case half the soluble salts are chlorides
8	*Arthrocnemum halocnemoides*, var. *pergranulatum*	Koonamore Lake near Head Station	25·3	8·8	41·3	4·97	·41	·68	5·7	8·2	Clay and fine quartz particles, gypsum crystals	
9	Junction of *A. haloc.*, var. *pergran.*, and *Atriplex vesicarium* (? var.)	Do. (at margin)	7·5	2·4	32·6	1·30	·03	·05	2·8	7·8	Somewhat fine quartz sand	The percentage of chlorine here very low
10	*A haloc*, var. *pergran.*, and *Atriplex spongiosum* and *Atriplex halimoides*— Surface soil	Koonamore, flat flooded by overflow from lake near Head Station	5·9	3·1	36·2	·85	·03	·06	3·0	7·8	Fine quartz sand Do	Percentage of chlorides increases with depth and conversely total salts decrease. Gypsum more efflorescent than sodium chloride, percentage of sodium chloride very low
11	2-6 inches depth ..		7·3	3·7	36·4	·73	·07	·12	4·4	7·8	Somewhat coarser quartz particles	
12	6-12 inches depth ..		11·0	6·7	36·6	·46	·17	·22	5·0	7·8		
13	*A. haloc*, var. *pergran.*, with *Atriplex limbatum* and annual species of *Atriplex* (below ecotone line)	Do. (at foot of sandy ridge)	4·1	2·1	35·0	·34	·01	·02	2·2	7·6	Fine quartz sand	These 3 samples are a series ascending from the flooded flat to the summit of a sandy ridge rising from it
14	*Atriplex limbatum* (above ecotone line)	Do. (higher up ridge)	2·9	·9	29·3	·06	·01	·02	1·1	7·8	Coarse quartz sand	
15	*Myoporum platycarpum*, *Acacia Oswaldii*, annuals, some *Atriplex vesicarium*	Do. (top of sandy ridge)	2·3	·9	25·0	·04	·01	·02	·7	7·8	Do	

temperature, filtering through a Chamberland-Pasteur candle and an aliquot portion examined for total salts and chlorides. The values obtained are consistently low except in soils from the salt lakes or their overflow.

The loss on ignition is low and varies little, the highest value being in the salt lake. The figures in this column represent the loss obtained after igniting the soil at a red heat, moistening with saturated ammonium carbonate to convert lime into carbonate and gently igniting to expel excess of ammonium salts. It represents, therefore, humus plus combined water.

The pH values were determined colorimetrically with Clark and Laub's sulphonephthalein indicators. The values are constant for *Atriplex* communities, viz., 7·6 to 7·8. The effect of the abundance of soluble salts in the lakes is reflected in a higher value for the pH, 8·2 in each case, approximately that of sea water. The last column gives a description of the soils based on microscopic examination.

Distribution of Chlorides.—It will be seen from soils Nos. 10-12 that the percentage of sodium chloride increases and that of total salts decreases with depth, also that chlorides form a small proportion of the total salts. In soil No. 7 from Nillinghoo Lake over one-half of the total salts are chlorides, even in the surface layers. The cause of the difference in distribution is explicable when the physical nature of the soils is examined. Nos. 10-12 are very fine sands, No. 7 is a coarse sand. The soluble sodium chloride, while more easily leached from the coarse sand than from the fine, is conversely able to rise in solution much more quickly in the coarse than in the fine. The less soluble the efflorescent calcium sulphate becomes accumulated at the top and this is quickly diluted with sodium chloride in the Nillinghoo Lake soil.

Biotic.

A detailed consideration of the biotic features will not be given in this paper. The indigenous mammalian fauna appears to have little effect on the plant life. The insect fauna, on the other hand, at times exercises great influence, *e.g.*, in plagues of grasshoppers or caterpillars. Biotic factors of moment are the incursive white man with his domestic animals and vermin, especially rabbits. All these animals affect considerably the constitution or facies of a flora which in its undisturbed condition was in a state of very delicately balanced equilibrium owing to the severity of climatic factors.

Vegetation.

Over so large an area many plant communities exist, though owing to the relatively even nature of the terrain, the similarity of the climatic and soil factors, the same community may extend for 100 square miles or more without notable change other than that occasioned by a local swamp. Such changes as do occur are often puzzling, especially the presence or absence of such trees as mallee eucalypts, black oak *(Casuarina lepidophloia)*, sandalwood *(Myoporum platycarpum)*, or mulga *(Acacia aneura)*, as an overgrowth of trees above the saltbush or in cases even replacing it. Into the inter-relationships of the communities recognizable in the field we do not propose to enter in this paper; a few of them only are described for purposes of comparsion with the halophytic vegetation of the flats.

Saltbush—*Atriplex vesicarium* community.

This is a dwarf shrubland of half-woody bushes 40-60 cms. or more in height. The bushes grow close together but rarely touch, the area of bare ground between them depending on the vigour of the plants, the amount of rainfall

during the preceding seasons, and the heaviness of the stocking. Naturally, land that has been "spelled" for a season or two with no sheep upon it, and only browsed upon by occasional kangaroos, shows much denser growth of bushes than an area carrying sheep.

The individual bushes grow erect and branch freely, the leaves are 2-5 cms. long and about 1 cm. broad, somewhat succulent, with a scurfy covering of fleshy hairs. Associated with *A. vesicarium* may occur other half-shrubby species such as *A. stipitatum* and *A. paludosum*. Annuals are many, but their abundance and type depend upon the season at which a heavy rain has occurred. Following summer rains grasses, especially *Stipa* spp., are most abundant. The plants most prominent in Spring are chiefly Compositae, *e.g.*, *Helichrysum polygalifolium*, *H. hyalospermum*, etc., and Cruciferae, *e.g.*, *Erysimum lasiocarpum*. Pl. xxxv., fig. 1, shows a view of a typical *Atriplex vesicarium* community. It will be seen that the plant covering is remarkably uniform, even to the horizon about two miles away. The soil of this area on Koonamore Station is analysed as sample 1. It will be seen from the table that the soil when collected was dry, but that the moisture at saturation (38 5 per cent.) indicates a fair water-retaining capacity. The total salts were only 1 per cent. of the dry weight, of which only·05 per cent. was chlorides. Soil sample 2 is from a similar community, but collected four months previously at Dilkera, approximately 120 miles to the south. The essential similarity between the two soils is apparent.

Mallee (*Eucalyptus oleosa*) with saltbush.

This community consists of a mallee scrub with an undergrowth composed largely of saltbushes. Various eucalypts are involved, but *E. oleosa* is most abundant. The plant is a typical mallee, growing from a large subterranean rootstock, with several equal trunks, especially in the young stages. Older plants are more tree-like with perhaps but a single trunk arising from an enlarged subterranean base. The height varies from 15-30 feet or more. The leaves have the usual pendant habit of eucalypts and are clustered at the end of the branches, so that the characteristic canopy top is produced (pl. xxxv., fig. 2).

Other trees or tall shrubs associated with the mallees are:—

Exocarpus aphylla	*Heterodendron oleaefolium*
Fusanus acuminatus	*Lycium australe*
Acacia Oswaldii	*Myoporum platycarpum*
Templetonia egena	*Pholidia scoparia*

These are all subordinate to the mallee in this community, though locally some of them, *e.g.*, *Templetonia* or *Pholidia*, may become so abundant as to give a distinct facies to the area. The undergrowth is of *Atriplex vesicarium*, with *A. paludosum* or *A. stipitatum* or locally *Kochia sedifolia*. The bushes are generally smaller and more scattered than in the community previously described. They are, however, sufficiently numerous to give a definite character to the vegetation, which thus differs from mallee communities, such as are developed further south and outside the area under investigation, by the presence of saltbush and the more open growth of the mallee.

Soils from this community are Nos. 3 and 4. Comparing No. 3 with No. 1 (pure *Atriplex*), collected on successive days about 50 miles apart, it will be seen that they are very similar, except that the mallee saltbush soil was drier, has a slightly lower percentage of water at saturation, and possesses nearly twice the amount of soluble salts (18 per cent.). The percentage of chlorides in the two soils is identical. Indeed, samples 1-4, although taken at different times and over a wide range of country, agree remarkably.

For comparison with these we repeat as sample No. 5 the analysis of soil from the *A. stipitatum* community at Port Wakefield. This, as was explained in our previous paper, is a degenerate saltbush community owing to human interference, but the relics of the vegetation suggest a community of the type described above. The analysis shows a soil of similar water-retaining capacity, but with more soluble salts, though appreciably less sodium chloride.

Mallee saltbush community is more prominent in the south of the area under discussion than in the north. From the rainfall diagram (text fig. 2) it is seen that the annual precipitation in the south (*e.g.*, Florieton) is greater and also shows a more pronounced winter maximum than the northern stations.

Kochia planifolia community.

Kochia planifolia—a bluebush—forms a very uniform community over the country around Curnamona. The terrain here is an even plain with no marked physical features. The dominant plant forms rounded shrubs, 5-1 meter in diameter. The bushes branch freely and bear numerous sub-cylindrical leaves, slightly flattened above and somewhat constricted at the base. The leaves are 1-2 cms. in length, covered by a dense tomentum of hairs. The bushes are scattered with 3 or 4 feet of bare ground between neighbouring plants (pl xxxv., fig. 3).

Scattered, tall shrubs occur over the *Kochia planifolia* community. These are *Cassia Sturtii, Eremophila Sturtii* (turpentine bush), and *E. glabra* (tar bush). The individual bushes are about 2 m. in height and often occur in small thickets. Trees, chiefly mulga (*Acacia aneura*), occur rarely, being limited to local groves where the soil is more sandy.

Kochia planifolia usually forms a remarkably pure community. In places, however, there is associated with it *K. Georgii, K. pyramidata,* or even *Atriplex vesicarium.*

Soil from the *K. planifolia* community is analysed as sample 6. In appearance it is a reddish loam, distinctly more compact than that on which most of the *Atriplex vesicarium* communities occur. Analysis shows that the soil has a lower water-retaining capacity at saturation and is poorer in soluble salts (08 per cent., of which only 02 per cent. is sodium chloride) than the soils previously described. We are of opinion that *K. planifolia* forms a community of a more xerophytic type than *Atriplex vesicarium.*

Kochia sedifolia community.

Kochia sedifolia, the most widespread bluebush in South Australia, occurs as a pure community in parts of the area, being associated with soils on travertine limestone. In the Murray Basin this community is often extensively developed, though the local abundance of the plant may be in some degree secondary, owing to selective grazing, *K. sedifolia* being less acceptable to stock than *Atriplex* spp. At Dilkera, *K. sedifolia* grows with *Atriplex vesicarium* and *A. stipitatum* under an overgrowth of mallee and *Myoporum platycarpum.* Near Morgan, on the Murray, there are extensive areas of *K. sedifolia* and *M. platycarpum* forming an obvious degenerate community owing to grazing.

Adamson and Osborn have described an extensive *K. sedifolia* community on the Nullabor Plain at Ooldea. They are of opinion that it is of a more xerophytic type than the *Atriplex vesicarium* community. With this deduction our results obtained in the present investigation are in agreement.

Arthrocnemum halocnemoides, var. *pergranulatum,* community.

This community is developed on gypsum salt swamps. In general appearance the variety is similar to the typical form of the species found on the saline

areas at Port Wakefield. Soil from a typical *A. halocnemoides*, var. *pergranulatum* community is analysed as sample 8. The total salts is high (4 97 per cent.), though sodium chloride is only 68 per cent. At Port Wakefield *A. halocnemoides*, var, *pergranulatum*, was found growing above the zone occupied by the typical *A. halocnemoides* as a few isolated bushes in the *Atriplex paludosum* consocies. The variety, therefore, does not seem to be able to tolerate an excess of sodium chloride. Pl. xxxvi., fig. 1, shows this community at Koonamore. The plants form thickets in which *Arthrocnemum leiostachyum*, a stouter growing species, is also present, but in small quantity. The gypsum-saturated ground between the bushes is bare, only a few annuals being present, including *Babbagia acroptera, Atriplex spongiosum, Mesembryanthemum australe*, and *Capsella elliptica*.

The boundaries of such swamps are ill-defined, because in time of exceptional flood, the waters may transgress their proper limits, submerging the surrounding country for miles. These transition zones are occupied by *Arthrocnemum halocnemoides*, var. *pergranulatum, Frankenia serpyllifolia, Babbagia acroptera, Heliotropum curassavicum, Atriplex limbatum*, with which such annual species as *Atriplex spongiosum, A. halimoides, Bassia patenticuspis, B. obliquicuspis*, etc., compete (pl. xxxvi., fig. 2). The species of *Atriplex*, especially *A. spongiosum*, are pioneer plants in many situations. The same may be said of the Bassias, which are a prominent feature in early phases of succession in the area.[15] The soil analyses of this flooded area, samples 10-12, show that it is quite possible for the shallower rooting annuals to be relatively non-halophytic compared with deeper rooted perennial species growing alongside them. The salt content in the first 2 inches of soil is 85 per cent. total salts, sodium chloride 06 per cent., while at a depth of 6-12 inches, the total salts are 46 per cent., of which 22 per cent. is sodium chloride. Samples 13-15 were taken above and below an ecotone line dividing the flora of a flood plain of the type described above from that of a sandy, limestone rise. The total salt content falls from 34 per cent. to 06 per cent. The water at saturation shows that the water-retaining capacity of the soil also decreases markedly. The change in the vegetation at such a junction is abrupt. The Arthrocnemum disappears first, then the annual saltbushes, *Atriplex limbatum* persisting higher up the rise. On the sandy rise itself occur *Acacia Oswaldii, Myoporum platycarpum, Rhagodia spinescens, Atriplex vesicarium*, and annuals, *e.g., Tetragonia expansa, Zygophyllum ammophilum*, etc.

Pachycornia tenuis community.

This plant forms a monospecific community on the floor of a large lake at Nillinghoo, near Koonamore (pl. xxxvi., fig. 3). The plants are dwarf, semi-prostrate, succulent, and herbaceous. Gypsum can be seen as a white efflorescence on the bed of the lake between the plants. The soil, sample 7, contains 6 60 per cent. of soluble salts, sodium chloride being 3 52 per cent. At the margins of the lake, *Arthrocnemum halocnemoides*, var. *pergranulatum*, appears, and finally replaces the *Pachycornia*, which is the more salt-tolerant species.

Discussion and Conclusion.

In this paper we have given an account of the Chenopodiaceous plant communities occurring in the plains and peneplains of the arid North-east of South Australia. We have omitted reference to the vegetation of steep hill slopes, because the communities developed in such situations do not bear immediately upon the question under discussion. The Chenopodiaceae is relatively unimportant in such communities, species of *Acacia, Eremophila, Zygophyllum*, etc.,

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(15) *C.f.* Collins, *loc. cit.*, p. 253.

being dominant. These hill slope communities are of essentially similar type to those described by Cannon at Copley and Collins at Broken Hill.

The vegetation of the plains and peneplains is composed of a number of communities in which one species or another of *Atriplex* or *Kochia* is very prominent, usually being dominant, or less frequently co-dominant, or even subordinate to mallee eucalypts. The conditions under which these communities grow are remarkably uniform, considering the area over which they are distributed. There is a gradual but progressive aridity as one proceeds north. Concurrently with the decrease in rainfall is its greater unreliability and also the diminishing importance of the winter rains (text fig. 2). Under such conditions the mallee eucalypts become less important, and finally, towards the north of the district, disappear entirely. At Koonamore they are limited to selected areas, the conditions obtaining there being apparently those of the ecological limit in the distribution of mallee. This appears also to be the case at Broken Hill.

The Chenopodiaceae, on the other hand, become increasingly important as one proceeds north. Of the many communities developed that are dominated by Chenopodiaceous plants we have referred here only to the more prominent. We intend at a later date to describe these in greater detail, together with some others, and to discuss the trend of succession in the district. The communities developed have, on the whole, a stamp of distinct uniformity, whether they have *Atriplex vesicarium* or other species (*e.g.*, *A. paludosum* or *A. stipitatum*), *Kochia planifolia*, or even *K. sedifolia*, as dominants.

Analyses show that the soils are of much the same type (samples Nos. 1-6). They are low in salts, whether total salts or chlorides. There is also, so far as we have determined, little variation in the water-retaining capacity. Briggs and Schantz [16] have shown that the amount of water a given soil is capable of holding varies from 23.2 per cent. in coarse sand to 69.5 per cent. of the dry weight of the soil in the case of clay loam. The range of saltbush-bluebush soils show an average water-retaining capacity at saturation of 36 per cent., which approximates to that of fine sand. *Atriplex limbatum* is able to grow in soil with only 25-29 per cent. of water at saturation. This is near the limit of the range shown by Briggs and Schantz, and suggests that *A. limbatum* is able to grow with a lower water supply than *A. vesicarium* or the other perennial species. *A. limbatum*, which is a shallow rooting species, was the only perennial saltbush growing on the flat (samples Nos. 10-12) flooded by water overflowing from the Gypsum salt lake near Koonamore. This area was sufficiently saline to determine a halophytic flora, the total salts ranging from 85 per cent. in the surface soil to 46 per cent. at a depth of 6-12 inches. The sodium chloride, which in the surface soil is only 06 per cent., reaches 22 per cent. at the greater depth. The boundaries of these flooded areas are difficult to define, and along their edges a mingling of communities takes place. Thus *Atriplex vesicarium* (? var.) was found growing near to a typical *Arthrocnemum halocnemoides*, var. *pergranulatum*, community in soil with 1·30 per cent. total salts, of which, however, only 05 per cent. was sodium chloride (sample No. 9). A point which requires further investigation is the calcium-sodium ratio. Excess of calcium ions do not appear to exert so marked a toxic effect as sodium ions. Warming [17] has shown that the extent to which a soil dries out influences its halophytic nature. "When the soil dries readily a small amount (perhaps 1 per cent.) of salt may expel all plants save halophytes, whereas if the soil does not dry readily perhaps 2.5 per cent. of salt is required to act in the same manner." In the flooded areas (samples Nos. 10-12) only ·68 per cent. total salts in the first

(16) Briggs and Schantz., H. L., Botan. Gazette, liii., p. 31, 1912.

(17) Warming, E., *loc. cit.*, p. 218.

12 inches of soil was sufficient to determine a distinctly halophytic flora. Of this 68 per cent., however, 13 per cent. was sodium chloride. In such a concentration of sodium ions the halophytic nature of the flora is more pronounced than in a soil with 1 30 per cent. of total soluble salts of which only 05 per cent. is sodium chloride (sample No. 9). Under such conditions *Atriplex vesicarium* (? var.) is able to persist on a flooded flat.

The soils of two distinctly halophytic communities have been analysed, samples Nos. 7 and 8. On neither of these were perennial Chenopodiaceae other than members of the Salicornieae growing. Nillinghoo Lake (No. 7), with 6 60 per cent. total salts and 3 52 per cent. sodium chloride had a pure community of *Pachycornia tenuis*. Koonamore Gypsum Salt Lake (No. 8) had a total salinity of 4 97 per cent., but with 68 per cent. only of sodium chloride. This area had dense thickets of *Arthrocnemum* spp. The bare ground between the bushes had such annual Chenopodiaceous plants as *Babbagia acroptera* and *Atriplex spongiosum*. These species, especially the latter, have a wide distribution and occur in several communities. They are not consistently halophytic, but are elements in the pioneer floras of several habitats in the district.

In conclusion, we have attempted to show that large portions of the interior of Australia are occupied by a distinctive type of arid flora. Other arid areas have, as is well known, developed their characteristic floras of xerophytes; the Karroo flora, in which the Crassulaceae are exceedingly prominent, is one very familiar example. In Australia the Crassulaceae is a family of minor importance, but the Chenopodiaceae is represented by numerous pronouncedly xerophytic species.

While the members of many arid floras have developed succulence as a characteristic structural feature, tending to the conservation of a considerable water balance in the plant, the Australian Chenopodiaceae are not specialized in this particular direction. On the other hand, they have attained a remarkable degree of xerophytism, by reducing their transpiration ratio to a minimum.(18) A feature of the climate in arid Australia is the quantity of "ineffective rainfall."(19) It seems probable to us that the leaf mechanism of the Chenopodiaceae with the large water vesicles of *Atriplex*, or the peculiar hairs of *Kochia*, may be connected with the utilization of this rainfall, which is ineffective so far as the roots of perennials are concerned. We shall publish observations on this question shortly.

DESCRIPTION OF PLATES XXXV. AND XXXVI.

PLATE XXXV.

Fig. 1. *Atriplex vesicarium* community at Koonamore (Alderman's).

Fig. 2. Mixed community of Mallee eucalypts (*E. oleosa*) with *Atriplex* spp. and *Kochia sedifolia* about equally abundant in the ground flora. Dilkera.

Fig. 3. *Kochia planifolia* community on plains near Curnamona. Bushes of *Eremophila glabra* forming scattered thickets on the horizon.

PLATE XXXVI.

Fig. 1. *Arthrocnemum halocnemoides*, var. *pergranulatum*, community on gypsum salt lake near Koonamore Head Station. In the foreground are scattered annuals, *e.g.*, *Babbagia acroptera, Atriplex spongiosum*, etc.

Fig. 2. Mixed community with *Arthrocnemum halocnemoides*, var. *pergranulatum*, and *Atriplex halimoides, A. spongiosum*, and *A. limbatum* on flat flooded by overflow from gypsum salt lake near Koonamore Head Station, seen in fig. 1.

Fig. 3. *Pachycornia tenuis* community on the bed of salt lake at Nillinghoo Lake, Koonamore. The white efflorescence of gypsum can be seen between the dwarf bushes.

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(18) Wood, *loc. cit.*, 1923.

(19) Cannon, W. A., *loc. cit.*, p. 47, 1921.

REPORT ON WORK CARRIED OUT UNDER RESEARCH GRANT FROM THE ROYAL SOCIETY OF SOUTH AUSTRALIA ON THE AZINE AND AZONIUM PRECIPITATES OF THE PROTEOLYTIC ENZYME TRYPSIN.

By Hedley Ralph Marston.

The chemical similarity and resemblance of the physical reactions of the protein bodies has led to the postulation of the chemical homogeneity of the protein group. The distinct specificity of the proteins from different sources, as shown by their biochemical activities, is remarkable in so much as the existence of a demonstrably distinct protein from each species of animal or plant must play an important role in the establishment of the morphological differences and uniqueness of physiological reactions which become manifest in the course of evolution of new species. The close resemblance, though non-identity, of the proteins from closely related species lends support to this hypothesis.[1] In the development of the organism, the building up of the protein from its amino acid integrals depends upon the catalytic effect exerted by the proteolytic enzymes. These possibly exert their synthetic activity in a water poor system existing at the surface of inert colloids within the cell.

The remarkable specificity of the hydrolytic activity which the proteolytic enzymes from different sources exert towards the various artificially prepared poly-peptids[2] suggests the inference that a similar specificity would be exerted in their synthetic activity. In other words, the specificity of the protein is established by the catalyst through whose agency it was synthetised, that is, by the proteolytic enzyme.

In the complex Metazoa, the specificity of the proteolytic enzymes from different tissues may be demonstrated by means of their selective activity towards synthetic substrates.[3]

The agency which brings about the differentiation of the tissue brings about a simultaneous change in the proteolytic enzymes in that tissue. These facts point to the possibility that the modification of the enzyme is determined by physico-chemical conditions existing in the chromosomes, and so is closely allied to the primary factor of tissue differentiation.

With the elucidation of the structural configuration of the proteolytic enzyme and its physico-chemical relationship with its substrate, the biologist will accomplish a very decided step towards clarifying his conceptions of living matter. The failure of the chemist to purify and identify the enzymes is due to the fact of their extreme sensitivity to changes in the physical environment.

Some years ago, T. Brailsford Robertson pointed out the occurrence of a precipitate when a solution containing the proteolytic enzyme trypsin was added to a solution of saffranine.[4] This observation was confirmed by Holzberg[5] who demonstrated the proteolytic activity of the precipitate so produced. The work, of which this is an account, was undertaken to study the nature of the groupings which were responsible for the production of this precipitate.

(1) Nuttall, G. F. H., "Blood Immunity and Relationship," Camb. University Press, 1904.

(2) Adberhalden, E., and Collaborators, Zeit. fur Physiol. Chem. Numerous papers appearing in this journal between 1904 and 1914.

(3) Abderhalden, E., Zeit. fur Physiol. Chem.

(4) Robertson, T. Brailsford, Jour. Biol. Chem., vol. 2, iv., p. 342.

(5) Holzberg, H., Jour. Biol. Chem., vol. xiv., 1913, p. 335.

PREPARATION OF THE SAFFRANINE PRECIPITATE FROM CRUDE TRYPSIN.

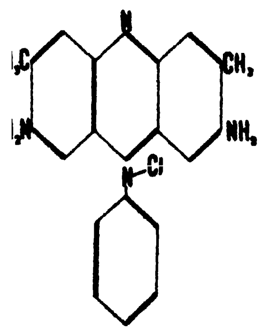
Fifty grains of dried pancreas tissue was extracted with 500 cc. of water, the reaction being adjusted to pH 7·8. The insoluble portion was then separated by filtration. To the amber-coloured filtrate 500 cc. of 5 per cent. saffranine was added, and the resulting precipitate allowed to flocculate for half an hour. It was then separated by centrifugalization and the sedimented precipitate washed twice with 5 per cent. saffranine. The excess of saffranine was then removed by washing five times with dry acetone. The precipitate was then dried over sulphuric acid at 40 deg. Cent.

The precipitate produced in this manner is a reddish-violet finely-grained powder. It emulsifies in water and goes partially into solution on adjusting the reaction to neutrality. The solution is reddish-violet in colour and is remarkably active in hydrolising protein substrates.

The yield of precipitate was about 2 per cent. of the original pancreas tissue employed.

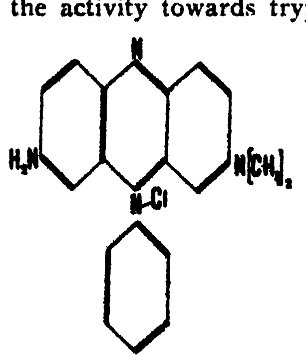
The precipitate is hydrolysed by dilute acids. Hydrochloric acid, in half normal concentration, will decompose the precipitate and liberate the saffranine as the dye hydrochloride, which may be extracted by butyl alcohol.

On the examination of the precipitating base, saffranine, it will be observed that there are two possibilities for the union of acidic groups. Saffrine has the constitution diamino-phenyl-toluazonium chloride.



It has two amino groups free to exert their activity towards electro-positive substances. The heterocyclic azine nucleus is also a decidedly reactive group. So there exist two possible points of union for a substance that is predominantly electo-positive. That trypsin is acidic in nature was shown by Bayliss,[6] who demonstrated the migration of trypsin to the anode when subjected to the influence of an electric current.

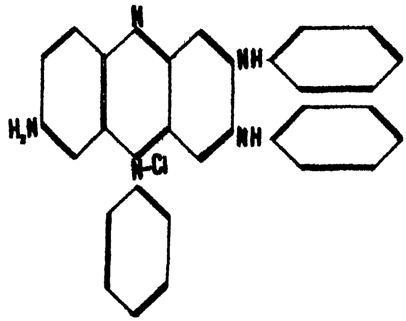
With a view to ascertaining the nature of the linkage between the enzyme and the saffranine molecule the activity towards trypsin of a series of similar



(6) Bayliss, Wm., Jour. Biol. Chem., vol. i., p. 225, 1906.

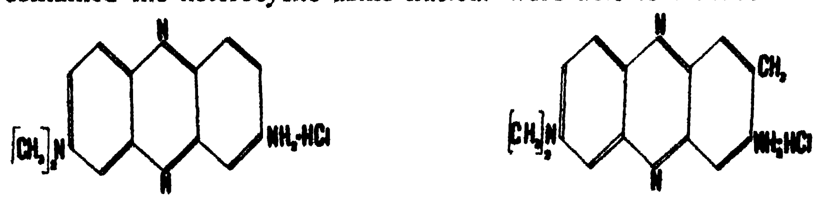
bases was determined. For example, phenosaffranine (diamido-phenyl-phenazonium chloride) was synthesised and found to exert a similar influence upon trypsin, precipitating it wholly from solution under favourable conditions of hydrogen ion concentration.

Dimethyl-diamino-phenyl-phenazonium chloride, synthesised by the mild oxidation of dimethyl-p-phenylene diamine and aniline; amido-dianilido-



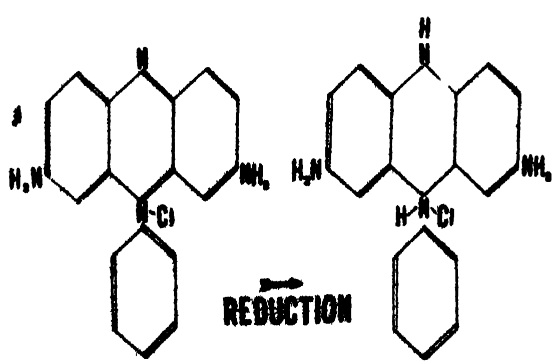
phenyl-phenazonium chloride prepared from amidoazobenzene and aniline hydrochloride, also precipitated the trypsin from its aqueous solution.

Simpler azine bases, the eurodines, also cause this precipitation. Thus dimethyl-diamido-phenazine hydrochloride (1), and dimethyl-amido-toluazine hydrochloride (2), were similarly active. All the water-soluble bases which contained the heterocyclic azine nucleus were able to remove the trypsin



(1) (2)

from solution. The reduced to leuko compound produced by reduction of the azonium base is incapable of this activity. In this compound the latent valencies of the nitrogen atoms of the heterocyclic azine ring have become saturated with hydrogen. Thus:—



Dye chloride (red). Leuko base (colourless).

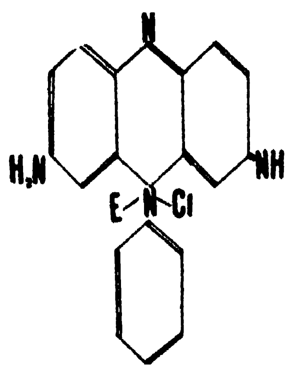
This addition of hydrogen destroys its basic properties. The reduction is accompanied by a colour change from red to colourless. The substance on re-oxidation regains its red colour, and at the same time its precipitating power.

The results of the preceding experiments are expressed in the following table:—

Azine Base.	Precipitates Trypsin.	Proteolytic activity of precipitate.
Dimethyl-diamino-tolu-phenazine hydrochloride	Yes	Pos.
Dimethyl-diamido-phenazine hydrochloride	Yes	Pos.
Saffranine, diamido-phenyl-toluazonium chloride	Yes	Pos.
Dimethyl-diamino-phenyl-phenazonium chloride	Yes	Pos.
Leuko saffranine	No	Neg.

Discussion.

The precipitation of the proteolytic enzyme trypsin completely from solution by the azine bases suggests that a compound of the enzyme and the base is formed. In the case of the azonium base, saffranine, the linkage would be represented thus:—



The enzyme compound would alter the constitution of the latter compound from the ortho- to the para-quinoid structure. This would institute a tautomeric change and would be accompanied by a change in colour. The compound produced from saffranine (which is itself red in colour) is reddish-violet when redissolved. This is possibly due to the occurrence of such a tautomeric change. The analogous non-acid salt of saffranine, violet in colour, occurs in solutions of moderately high hydrogen-ion concentration.

Conclusions.

It has been shown that the proteolytic enzyme trypsin is precipitated wholly from solution by the azine bases.

The nature of the groupings involved has been studied. It has been demonstrated that the heterocyclic azine ring is functional in this precipitation. The work is being extended.

I wish to acknowledge the kindly interest and helpful suggestions of Professor T. B. Robertson, and also the kindness of Professor H. M. Evans, of the University of California, in supplying two of the azonium bases employed in these experiments.

Darling Laboratories, University of Adelaide,
May 10, 1923.

ABSTRACT OF PROCEEDINGS

OF THE

ROYAL SOCIETY OF SOUTH AUSTRALIA
(Incorporated)

FOR THE YEAR NOVEMBER 1, 1922, TO OCTOBER 31, 1923.

ORDINARY MEETING, NOVEMBER 9, 1922.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

NOMINATIONS.—M. Sprod, M.B., B.S., and R. G. Thomas as Fellows.

PAPERS.—"Description of New Australian Lepidoptera," by OSWALD B. LOWER, F.E.S., F.L.S.; "Australian Staphylinidae (Coleoptera)," by ARTHUR M. LEA, F.E.S.; "Australian Fungi: Notes and Descriptions, No. 4," by J. BURTON CLELAND, M.D., and EDWIN CHEEL.

EXHIBITS.—Professor WALTER HOWCHIN, F.G.S., on behalf of Rev. J. C. JENNISON, exhibited samples of Asphaltum Glance, discovered *in situ* at Point Bristow, Elcho Island, on the northern coast of Australia. Rev. J. C. Jennison wrote: "I found quantities of it *in situ* in the sandstone strata of Point Bristow. There are mudstone strata above the sandstone, then 60 or 70 feet overburden of clay with ironstone capping." Professor T. G. B. OSBORN, D.Sc., showed a specimen of *Viscum articulatum*, Burm., growing on *Acacia linophylla* collected at Ooldea in August this year. This is the second time that the plant has been collected in South Australia. It is represented at present in the University Herbarium by a single specimen taken near Cooper's Creek more than twenty-five years ago. Mr. J. F. BAILEY exhibited a large green frog from Queensland Dr. R. H. PULLEINE exhibited a large number of aboriginal flint implements obtained from the north-west coast of Tasmania between Rocky Cape and Bluff Point. The mineral represented was Lydite or Lydian Stone.

ORDINARY MEETING, APRIL 12, 1923.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

NOMINATIONS.—James C. Marshall, Florence M. Hill, D.Sc., H. R. Marston, C. J. R. Glover, W. A. Magarey, LL.B., and J. G. Wood, B.Sc., as Fellows.

ELECTIONS.—M. Sprod, M.B., B.S., and R. G. Thomas as Fellows.

SCIENTIFIC HANDBOOKS.—The PRESIDENT brought before the notice of the meeting the Scientific Handbooks for South Australia which were being prepared by members of the British Science Guild (South Australian Branch), assisted by the Government, the second volume of which, by Professor F. Wood Jones, D.Sc., etc., on the "Mammals of South Australia," was now published.

Sir JOSEPH C. VERCO wrote resigning his seat on the Council on account of his absence in England for an indefinite period. Resolved—"That the resignation be not accepted, but that leave of absence for six months be granted."

Notices of the following INTERNATIONAL CONGRESSES were received:—Pan-Pacific Science Congress, in 1923, August and September, in Melbourne and Sydney; and Geographical and Ethnological Congress, in 1925, in Cairo.

Professor F. WOOD JONES, D.Sc., etc., gave a progress report of the work done by the Barrier Reef Council, on which he represented this Society.

PAPERS.—"Flora and Fauna of Nuyts Archipelago and the Investigator Group: No. 5, The Lizards," by JOAN PROCTOR; "No. 6, The Didelphian Mammals," by Professor F. WOOD JONES, D.Sc., etc.; "No. 7, The Fishes," by EDGAR R. WAITE, F.L.S.; "No. 8, The Ecology of Pearson Islands," by Professor T. G. B. OSBORN, D.Sc., with an Appendix on the Soils, by J. G. WOOD, B.Sc.

EXHIBITS.—Mr. E. R. WAITE showed a specimen of coral from Pearson Island obtained quite 20 feet above high water. Also stones from stomachs of seals on Pearson Island, some still surrounded by penguin feathers. Dr. R. H. PULLEINE exhibited a cylindrical aboriginal stone from near Broken Hill, 30 inches long, and believed to be the longest ever discovered. Another from the same locality was about 10 inches long. Mr. A. M. LEA showed gall insects received from Mrs. Klem, of Corny Point, which cause portions of the twigs of swamp ti-trees to divide into very close leaf-like layers.

ORDINARY MEETING, MAY 10, 1923.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

NOMINATION.—Roy S. Burden, B.Sc., was nominated as Fellow.

ELECTIONS.—J. G. Wood, B.Sc., Florence M. Hill, D.Sc., W. A. Magarey, LL.B., James C. Marshall, and C. J. R. Glover as Fellows.

Sir DOUGLAS MAWSON, D.Sc., F.R.S., received the hearty congratulations of the Society upon his election as a Fellow of the Royal Society.

PAPERS.—"The Structure and Action of Striated Muscle Fibre," and "On the Path and Velocity of the Excitatory Impulse within Striated Muscle Fibres," by O. W. TIEGS, D.Sc.; "Australian Lepidopleuridae, Order Polyplacophora," by EDWIN ASHBY, F.L.S., M.B.O.U.; "Flora and Fauna of Nuyts Archipelago: No. 9, The Birds of Pearson Islands," by Professor J. BURTON CLELAND, M.D.; "The External Characters of Pouch Embryos of Marsupials: No. 5, *Phascolarctus cinereus*," by Professor F. WOOD JONES, D.Sc., F.Z.S., etc.

EXHIBITS.—Mr. EDWIN ASHBY showed some paintings by his daughter of Australian native flowers. Mr. A. M. LEA showed a drawer of beautiful timber-boring moths, mostly from Queensland; also a curious centipede-like creature known as *Peripatus*. Professor J. B. CLELAND showed a number of birds in illustration of his paper on "The Birds of Pearson Island."

ORDINARY MEETING, JUNE 14, 1923.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTION.—Roy S. Burdon, B.Sc., as Fellow.

NOMINATIONS.—R. M. McBride, J.P., John Conrick, and Lester Judell, B.Sc., as Fellows.

PAPERS.—"A Review of *Ischnochiton (Haploplax) smaragdinus*, Angas, 1867, and its Congeners, together with the Description of Two New Chitons from Papua," by EDWIN ASHBY, F.L.S., M.B.O.U.; "A Bacterial Disease Destructive to Fish in Queensland Rivers," and "A Bacteriosis of Prickly Pear Plants (*Opuntia* spp.)," by Professor T. HARVEY JOHNSTON, M.A., D.Sc., and LEITH HITCHCOCK; "Flora and Fauna of Nuyts Archipelago: No. 10, The Francis Island Snake," by EDGAR R. WAITE, F.L.S.

EXHIBITS.—Mr. A. M. LEA exhibited a drawer containing powerful beetles, including some taken from animal droppings in Africa. Certain of the males had remarkable horns on the head and thorax, used in fighting for possession of the females. The Rev. J. C. JENNISON showed mosquito nets obtained by himself from the Crocodile Islands, Northern Territory. They are conical in shape, made from the leaves of the pandanus palm, and used chiefly for children,

fully protecting them from mosquitos. The men also use them by placing them over their heads while they sleep in a trough made in the sand. Mr. EDWIN ASHBY showed a large series of chitons in illustration of his paper.

ORDINARY MEETING, JULY 12, 1923.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTIONS.—R. M. McBride, J.P., John Conrick, and Lester M. W. Judell, B.Sc., as Fellows.

NOMINATION.—Norman B. Tindale as Fellow.

PAPERS.—"New Australian Micro-Lepidoptera," by A. Jefferis Turner, M.D., F.E.S.; "External Characters of Pouch Embryos of Marsupials: No. 6, *Dasycercus cristicauda*," by Professor F. WOOD JONES, D.Sc., F.Z.S.

EXHIBITS.—Mr. A. M. LEA exhibited a magnificent leaf-mimicking moth of the genus *Phyllodes* from the New Hebrides, sent by the Rev. A. Theo. Waters; also a small collection of beetles taken by Professor F. Wood Jones at McDouall's Peak, in the interior of South Australia, the more interesting species belong to the genera *Clivina, Scymbalium, Macromalocera, Pterohelaeus,* and *Strongylium.* Mr. EDWIN ASHBY exhibited a specimen and painting of the Ploughshare-leaved Wattle *(Acacia vomeriformis)* collected at Mylor; also six genera, including seven species, of land snails collected by him at Innsbruck, Tyrol; also American Humming Birds. Dr. PULLEINE exhibited a large perforated shell plaque of unknown age, made from the shell of *Tridacna* sp., from Vella la Vella, Solomon Islands, being the largest specimen ever recorded.

ORDINARY MEETING, AUGUST 9, 1923.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

THE PRESIDENT referred to the death of the late Thomas Gill, C.M.G., I.S.O., Honorary Fellow of this Society and Honorary Secretary of the South Australian Branch of the Royal Geographical Society of Australia. It was resolved that a letter of condolence be sent to his family; also that a letter of thanks be sent to the Royal Geographical Society, London, which had sent us an almost complete set of their publications, dating back to 1831.

ELECTION.—Norman B. Tindale was elected a Fellow.

NOMINATIONS.—Archibald Strong, M.A., D.Litt., and J. F. Thomas were nominated as Fellows.

PAPERS.—"Composition of the Waters of the Great Australian Artesian Basin in South Australia, and its Significance," by R. L. JACK, B.E.; "Notes on a Collection of Polyplacophora from Carnarvon, Western Australia, with Definitions of a New Genus and Two New Species," and "Review of the Australian Representatives of the Genus *Cryptoplax*," by EDWIN ASHBY, F.L.S., M.B.O.U.; "Survey of the Australian Sheep Maggot-fly Problem," by Professor T. HARVEY JOHNSTON, M.A., D.Sc.; "External Characters of Pouch Embryos of Marsupials: No. 7, *Myrmecobius fasciatus*," by Professor F. WOOD JONES, D.Sc.; "Australian Coleoptera, Part IV.," by ALBERT H. ELSTON, F.E.S.

EXHIBITS.—Mr. A. M. LEA showed a drawer of small cockchafer beetles, some of which are very destructive to the roots of grass. One species of *Maechidius* probably lives in the nests of ants, and has its appendages curiously modified. Professor F. WOOD JONES exhibited bones from Rocky River Station, Kangaroo Island, comprising *Diprotodon australis, D. minor, Sthenurus orcas,* and *S. atlas.* These were first found twenty years ago but not recorded. Recently, considerable quantities have been found, and it is hoped that detailed search will be made for more complete remains. Dr. R. H. PULLEINE exhibited cylindro-conical aboriginal stones from the Darling and Albemarle, near Menindie.

A SPECIAL MEETING was called for August 30, and adjourned to September 6 and September 13, to consider the recommendation of the Council to

amend the Rules and By-laws. THE PRESIDENT (R. H. Pulleine, M.B.) in the chair. After discussion, the recommendations of the Council were approved.

ORDINARY MEETING, SEPTEMBER 13, 1923.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTIONS.—J. F. Thomas and H. K. Fry, D.S.O., M.D., B.S., B.Sc., were elected as Fellows.

DONATION was received from Mr. J. Greenlees of an album of 100 photographs of glacial phenomena in South Australia taken by himself and other gentlemen, for which he was heartily thanked.

PAPERS.—"On the Zonation of the Vegetation in Port Wakefield District, with special reference to the Salinity of the Soil," by Professor T. G. B. OSBORN, D.Sc., and J. G. WOOD, B.Sc.; "Transpiration in the Field of some Plants from the arid portions of South Australia, with Notes on their Physiological Anatomy," by J. G. WOOD, B.Sc.; "The Gem Sands of Encounter Bay," by R. G. THOMAS; "A Geological Sketch-Section of the Sea-cliffs on the Eastern side of Gulf St. Vincent, from Brighton to Sellick's Hill, with Descriptions," by Professor WALTER HOWCHIN, F.G.S.

EXHIBITS.—Mr. A. M. LEA exhibited a collection of insects lately made by Professor F. Wood Jones at Stuart Range, including some wingless grasshoppers and others greatly resembling the stones amongst which they are found; a cockchafer beetle previously known only from Western Australia, and a fly that lives amongst the feathers of birds. Mr. N. B. TINDALE showed a small collection of butterflies made in the Finisterre Mountains and at Finschhaven, New Guinea, by Mr. S. Lehner, including the rare males of *Troides goliath* and *T. paradisea*, known as "Butterflies of Paradise" from their extreme size and beauty. Mr. E. R. WAITE exhibited some specimens recently received at the Museum, including articles from Thibet presented by Mrs. T. K. Hamilton. Human skulls are largely used by the Thibetans in ceremonial observances. A tambourine shown was composed of two skull caps fastened together at their vertices, the open ends being covered with membrane. Two trumpets made of human thigh bones were shown, those of criminals or of men who have died a violent death being preferred. They had each two expiratory orifices styled "the nostrils of the horse," a mythical animal believed to carry the faithful to Paradise. The sound of the trumpet reminds the people of the neighing of the horse.

ANNUAL MEETING, OCTOBER 11, 1923.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTION.—Professor A. Strong, M.A., D.Litt., was elected a Fellow.

The ANNUAL REPORT and FINANCIAL STATEMENT were read and adopted.

PAPERS LAID ON THE TABLE.—"Additions to the Flora of South Australia: No. 21," by J. M. BLACK; "Geological Features of the neighbourhood of Blackfellow's Creek, Mount Lofty Ranges," by Sir DOUGLAS MAWSON, D.Sc., B.E., F.R.S.; "Notes on Igneous Rocks of the Mount Painter Belt, Flinders Range," by Sir DOUGLAS MAWSON; "Flora and Fauna of Nuyts Archipelago and the Investigator Group: No. 11, The Coleoptera of Pearson Island," by A. M. LEA, F.E.S.; "No. 12, The Stomach Contents of Pearson Island Birds," by A. M. LEA; "No. 13, The Orthoptera," by N. B. TINDALE; "No. 14, The Basidiomycetous Fungi of Pearson Island," by Professor J. B. CLELAND, M.D.; "Australian Rhopalocera," by N. B. TINDALE; "Distribution of Australian Orchids," and "Contributions to the Orchidaceous Flora of Australia," by R. S. ROGERS, M.A., M.D.; "On some Halophytic and Non-Halophytic Plant Communities in Arid South Australia," by Professor T. G. B. OSBORN, D.Sc., and J. G. WOOD, B.Sc.

Election of Officers.—The following officers were elected for 1923-24:—*President,* R. H. Pulleine, M.B.; *Vice-Presidents,* R. S. Rogers, M.A., M.D., and Sir Douglas Mawson, D.Sc., B.E., F.R.S.,; *Hon. Treasurer,* B. S. Roach; *Hon. Editor,* Professor Walter Howchin, F.G.S.; *Members of Council,* Professor T. Brailsford Robertson and A. M. Lea, F.E.S.; *Hon. Auditors,* W. C. Hackett and H. Whitbread.

The Retiring President then gave his address, illustrated by lantern slides, on

"THE PIGMY RACES OF THE WORLD."

In view of the public interest that has been awakened of late years in the Pigmies, as a distinctive type, I have thought that perhaps a brief statement of our present knowledge of this interesting people might not be found unacceptable; I have, therefore, taken this subject for my Anniversary Address.

Historically, there is in Egyptian records ample evidence that the Pigmies were known to the Nile peoples, and were kept at their courts as curiosities. The actual place where they came from was also known, according to Brugsch ("History of Egypt," vol. 1, page 114), as the Land of Punt, or (?) Somali Land. The Greeks knew them as a distant legendary people. It was Herodotus who gave them the name, Pigmy, after a Greek measurement, equivalent to about 14 inches. Von Luschan, in 1883, recommended this term for anthropological use, in the place of dwarf, etc., to denote small races. It is strange that, in recent times, Gibbon, in 1859, regarded the Pigmies as legendary.

Du Chaillu was the first to record Equatorial Pigmies, in Gaboon, in 1867, followed by Schweinfurth, in the Ituri Forest, in 1870. After this they are frequently recorded, and a large literature has grown up around them, Stuhlmann and Casati (both with Emin Pasha), Livingstone, Stanley, Le Roy, and Sir H. H. Johnston being the principal early ones. It was while studying the Pigmies that Johnston made the discovery of the Okapi. People had been wondering where the natives got their beautiful zebra skin belts. It was Johnston, with the help of the Pigmies, who found out the secret. This, more than anything else, brought the little people into notice. Stuhlmann had by 1893 taken two Pigmy women to Europe, where they excited much curiosity, and were the only genuine ones seen up to that time, although alleged African Pigmies had been living in Austria and Italy. In 1905, six Pigmies from the Ituri (one a half-breed) were taken to Europe by J. J. Harrison. Dr. Elliot Smith, at that time Professor of Anatomy in Cairo, was able to examine them during their stay in that city (see "Lancet," August 12, 1905). Afterwards they passed on to London, where they remained several months on exhibition, and finally they were shown in other European cities, including Berlin, where they were exhibited before the Anthropological Society, and formed the subject of an interesting paper by Von Luschan (Z. für Eth., 38, 1906).

Barns, in his "Wonders of the Eastern Congo," 1922, gives an interesting and familiar account of their country. He was not the first who subjected the Pigmies to the cinematograph, for Shattuck and others, sent out by the American Museum of Natural History and American Universities in 1919-20, had taken much pains in recording the Pigmies and their dwellings and dances on the film, and this, I think, was the film that was shown in Australia.

Barns records that the Ituri Forest, the home of the Pigmies in Central Africa, is not as bad to travel in as is often reported, but he went along the Belgian Government road with rest houses provided at intervals. All travellers agree that once off the beaten track the Ituri Forest is about as difficult of penetration as any the earth presents. Not only is its inherent density beyond description, but the scandent plants, fallen trees, and rank undergrowth, together with animal pests, make it quite impenetrable, in many places, to the European

hunter. No wonder the Okapi remained so long unknown, and no wonder that still the Okapi hunter has to hire the Pigmies to help him.

There can be no doubt that the Pigmy is a very primitive type, and there is every reason to think that they are survivals of the primitive stock which has become geographically and ethnologically isolated among races that have had a different origin. It is our present purpose to briefly indicate the chief characteristics of these ancient and interesting peoples, as they are found to exist at the present day. They are widely distributed, but may be roughly classed into two main geographical groups—the African Pigmies and the Eastern Pigmies.

The African Pigmies.

The Equatorial Pigmies are distributed over the region included within 5 degs. North latitude and 17 degs. South latitude, and about 1 deg East longitude to 32 degs. East longitude; that is, including the whole watershed of the Congo and the Semliki. They are known in different areas by different names, and as the names are varied by different authors the position is complicated. Akka, Tiki Tiki, Wambuti, Batwa, Watwa, Obongo are the various names of the same or different tribes. They occur apparently in the greatest numbers along the Equatorial line, the Banana Belt of Africa, but are recorded from low down on the Congo Basin, joining up in the south with the Bushmen of Lake Ngami.

The Bushmen were formerly widely distributed in South Africa, reaching from the west coast to the east coast and from Table Mountain to Lake Ngami. Stow ("Native Races of South Africa") gives a graphic account of the former great distribution of this unfortunate race and the causes that led to its practical extinction. Living in a country that is more variable in contour and climate than that occupied by the Equatorial Pigmies, their life was less specialized in one direction, but more so in others, as there were Bushmen of the Mountains, of the Rivers, the Plains, the Sea Shore, and the Desert. The few pure Bushmen who still remain are probably the Kungs and Haikums of the north-west Kalihari, but there may be many more. The Kalihari is so vast that its aboriginal population is imperfectly known.

Traces of an aboriginal Negrito-Pigmy population are said to be found in Madagascar. These people were called Mazimba, Kimos, and Behosy, but, like the Abyssinian Dokos, they seem to have received little notice in literature.

The Eastern Pigmies.

In the Andaman islanders we find the only isolated Pigmy race at present living comparable, in their isolation, to the Tasmanians, and resembling that race in several remarkable anthropological and ethnological respects. The Andamanese, when discovered, and prior at least to the establishment of Port Blair as a convict settlement, were a pure negrito race, and their anthropology and ethnology have been admirably recorded in the works of Man and Portman.

The ethnological position of the Semang, who occupy the mountains that form the backbone of the Malay Peninsula, is not so clear. There are Semangs who are pure negritos and who conform ethnologically to the Pigmy type, but they are so scattered and surrounded by other races, who are absorbing them, that it seems unsafe to make dogmatic statements about their cultural characteristics. The Semangs are hemmed in by the Malayan coastal tribes and in close contact with tribes like the Senoi and Sakai, who, in themselves, provide problems. The student will find Skeat and Blagden's "Pagan Races of the Malay Peninsula" full of information on the Semangs and their neighbours.

In nearly all the larger islands of the Phillipines negritos have been observed. They are, as a rule, displaced from the coast and occupy the more inaccessible parts of the islands, and chiefly come in contact with the Tagals and Vicols.

Negritos have been reported as occurring in Borneo, but Dr. Eric Mjoberg, now Director of the Museum at Kuching, writes that they are unknown to him.

Formosa, too, has been credited with the possession of a Pigmy race. Miss McGovern in her book, "The Head Hunters of Formosa," tells of a little people a little over 4 feet high with crinkly hair. Dr. Oshima, a Japanese zoologist, and delegate to the Pan Pacific Congress, 1923, who has been in Formosa fourteen years, informs me that he cannot corroborate this statement.

Wollaston and his party discovered the Tapiro Pigmies in the mountains of Dutch New Guinea, in 1910, and, a little later, Williamson's book on the Mafulu People of British New Guinea, gave some references to a Pigmy race in the British portion.

Neuhauss, in his "Deutsch Neu Guinea," figures and gives accounts of Pigmies discovered by Keyser in the Sattelberg, and by Poch, in the Goliathberg Their nearest neighbours on the seaward side are the Papuans, who, again, are displaced from the shore by the coast-loving Melanesians.

In New Britain the Sulka people declare that a race of small men lives in the caves in the ranges of the centre of the island and comes down to steal their bananas. On the Gazelle Peninsula, at the eastern end of the same island, live the Baining (a curly-haired race forced into the mountains by the ubiquitous Melanesians), a wandering people who cultivate a little taro, and whom Parkinson, in his "Dreissig Jahre in der Sudsee," characterises as "in every particular an absolutely primitive and simple folk such as I have never encountered anywhere else in the South Seas."

Felix Speiser, in his "Two Years with the Natives in the Western Pacific," gives an account of the Pigmies in Santo. This, I understand from Professor Skinner, is authenticated by Dr. Bowie, of Ambrym.

Physical Characteristics.

The Pigmies are small races which show no marks of degeneration. To lay claim to the distinction of being a Pigmy, the males must average under 5 feet in height; the Pigmy, like a child of twelve, is six heads high as against eight heads high for an average Englishman and nine and a half heads high for a Nilotic Dinka. Thus their heads look relatively large for the small body. Von Luschan says that the cause of the diminutive stature is an early cessation of growth rather than a decrease of the yearly increment while growth is actually taking place.

Sir H. H. Johnstone gives the average height of the Equatorial Pigmies as 4 feet 7 inches for men and 4 feet 2 inches for women, the minimum being 4 feet 2 inches and 4 feet, respectively. Other observers record still lower minima.

For the Bushmen, Fritsch gives 4 feet 9 inches and Barrow 4 feet 6 inches for men and 4 feet for women. Fritsch's figures are probably more reliable for a large number. Of the Asiatic or Eastern Pigmies, the Andamanese average is 4 feet 10½ inches (Haddon); the Semang, 4 feet 10¾ inches (Haddon); the Aetas, 4 feet 10 inches (Haddon); the Tapiros, of New Guinea, 4 feet 9 inches (Rawling).

In general physique all the Pigmy races are sturdy and well built, with good muscular development. The hands and feet are generally small in proportion and the great toe markedly drawn inwards away from the second toe. The abdomen is prone to be protuberant, especially in the children, and the buttocks are, as a rule, markedly prominent, although the steatopygia with which the Bushmen are credited is, according to Fritsch, not authenticated, as the Bushmen women show far less of steatopygous deformity than the Hottentots.

The Equatorial Pigmies, as well as the Bushmen, are, on the average, mesaticephalic, while the Asiatic Pigmies are all inclined to be brachycephalic.

The cephalic indexes of the respective peoples are as follow:—Andamanese, 82; Semang, 78·9; Aetas, 80 (Haddon); while the Tapiros are 80·2 (Rawling), and the Kai Pigmies over 80 (Neuhauss). The nose in all the races is low at the bridge and very broad, and the alveolar margin of the upper jaw prominent. This, with the flat nose and weak chin, gives rise to a prognathism.

Among the Equatorial Pigmies, Stanley and Johnstone distinguish two types in relation to the colour of their skin—one with reddish or yellowish-brown skin and a tendency to red in the hair, and the other a black-skinned type with entirely black scalp hair. The Bushmen are stated to be reddish or yellowish, much lighter than the negro, but their colour varies with the different tribes. In Asia the negritos are all classed as dark brown.

The peculiar type of hair to which all Pigmies must conform is the short curly hair of the so-called peppercorn type. While this hair is found in all the races, African and Eastern, it reaches its special development in the Bushmen. In colour it is in all the races a dark brown, sometimes nearly black, at others with a tinge of red in it. The body hair is curly and of the same colour, which is well developed on the ventral surface. Amongst some of the Congo and Ituri Pigmies there is a remarkable development of fine lanugo (which is especially evident in the sunlight), as well as beards that are sometimes of considerable length.

The particular anthropological characteristics of the Pigmies are, short stature, a broad head, and typical curly hair, in contradistinction to the Negroes, who are characterised by tall stature, long head, and curly hair.

Arts and Customs.

In discussing the stage of culture of the Pigmies, only those facts will be mentioned which concern them apart from the influence of adjacent peoples.

As all the races live in hot climates clothing can be, and is, reduced to the possible minimum. The Equatorial Pigmies mostly go naked in the forests; at most, they wear a bark girdle, in which the women stick large leaves before and behind The Bushmen wear a leather perineal band, while their women wear two short leather aprons, the larger one covering the buttocks. In cold weather there is worn, in addition, a skin caross sufficiently large to envelop the body. The Andamanese are contented with a string girdle, in which bunches of leaves are placed, after the fashion of the Equatorial Pigmies. The same fashion is observed by the Semang, while the Negritos use perineal bands of bark enlarged into an apron by the women. Wollaston observed that the Tapiro men had nothing on but a phallocrypt formed of a gourd. The women were not seen.

Sparing as the Pigmies are in their dress, they are still more so in their decorations. Mutilations, so common amongst races of greater stature, are unknown, if we except the alleged amputation of a little finger-joint by certain Bushmen, and in no race is circumcision a practice. Real tattooing is entirely absent and scarification confined to the Andamanese and the Aetas of the Philippines. Our information as to the use of pigments is incomplete, but they appear to be sparingly used by the Akkas and the Bushmen, and extensively so by the Andamanese. Of ornaments the primitive Akkas seem to know nothing, while the Bushmen make necklaces and other ornaments of discs of ostrich shell, for the manufacture of which they have a special technique. The Asiatic Pigmies are much fonder of ornaments, the most interesting being the magic combs of the Semang worn by the women to avert disease. The Andamanese, as in the case of the extinct Tasmanians, wear the bones and skulls of their deceased relations.

The various races are, without exception, hunters and collectors of food. Cultivation and pastoral pursuits are unknown to them. They are great hunters

and no game is too large for them to engage. Their whole life is founded on a complete knowledge and acute observation of the plant and animal life in their own region. Their weapons are almost exclusively the bow and arrow, which among the African tribes are quite small. Among the Akkas the arrow is tipped with pieces of bone or borrowed iron and feathered with a strip of palm leaf. The African races poison their arrows, and, according to Stanley and others, the poisons used by the Equatorial Pigmies are astonishingly quick and deadly. The arrow poison of the Bushmen, partly vegetable *(Euphorbia* and *Amaryllis)* and party animal, is also deadly to the ostrich and large ungulates. In the Andaman Islands a peculiar form of bow is met with which has the form of an S and is nearly as high as the archer himself. The arrows of this race are not poisoned.

Being, as a rule, ignorant of pottery (except among the Andamanese), the preparation of food is mostly by baking. The food, in all races, includes everything edible in the animal and vegetable world. Everything that will provide protein is utilized on occasion. The Bushmen will even eat hyaenas, and their favourite foods are the giant frogs, the pupae of termites, and the locusts or grasshoppers which appear in clouds at certain seasons.

Like all inland people, the Pigmies value salt, and among the Ituri Akkas it is much sought after and is currency for paying the hunters. To get carbohydrates the Pigmies in the banana zone obtain the banana by exchange or theft, although actual theft is not the rule, meat being left where the Negroes can find it. Amongst the Bushmen the cycad provides the needed starch, and the Asiatic races have wild rice, sweet potatoes, and other means of meeting this necessity of life. Honey is especially prized as a food, and the Bushmen (before the advent of the Europeans) had discovered that an intoxicating drink could be made from its fermentation.

The Pigmy races are without exception nomadic, and in their uninfluenced state erect nothing worthy of the name of villages or large dwellings, having at most, as amongst the Andamanese, a large building to which they can return from time to time as a rendezvous, much as the Bushmen return to their caves when driven by circumstances. Cold and rain are the factors which modify the architecture of nomadic peoples, and the Pigmies use in the simplest forms wind screens made of branches and leaves, or, when necessary, hemispherical huts thatched sufficiently to make them waterproof. These may be only of materials gathered from the immediate neighbourhood, or a palm-leaf thatch may be prepared and carried about (Andamanese), or carefully made rush mats (Bushmen), eventually improved by skins and hides.

Reed ("Negritos of Zambales") figures a house raised off the ground, and the Tapiros, living in a mountain rain-forest, build their rectangular thatched huts on a platform several feet from the ground (Wollaston, p. 206). The Semang utilize natural shelters under rocks and the simplest form of leaf shelters. They differ from all other tribes of Pigmies by also having large leaf shelters, furnished with bamboo bed places, and capable of accommodating the entire tribe. All observers agree that whatever their dwellings are they pay little attention to cold, and sleep soundly on the coldest nights without any covering.

With the doubtful exception of the Tasmanians, the Andamanese are the only people on record who at the time of their discovery were unacquainted with the means of making fire. It seems almost certain that the Tasmanians were acquainted with the friction method. The Andamanese always kept a smouldering log in their camps and carried fire with them when travelling. The original fire of the Andamanese is supposed to have been obtained from volcanoes, of which there are two on the islands, only one of which is now active. The

Semang use the rubbing method and also the fire saw.' The Negritos use the fire saw, which is also the method adopted by the Tapiro Pigmies. The Equatorial Pigmies and the Bushmen both use the fire drill, exclusively.

According to all authors, the Central African Pigmies use the language of the adjacent tribes, generally corrupt Bantu dialects. They are good linguists and pick up languages very quickly. The language is sometimes an archaic form of Negro language, or it may be the language of a people separated from them by the territory of several other tribes. Whether they also have a primitive language of their own does not seem to be certain. An investigation in relation to this point which was made on the Pigmies during their European visit led to no definite results. The Bushmen have a characteristic language which, like the Hottentots, abounds in clicks, palatal, dental, labial, inspiratory, and expiratory. As there are six kinds of these clicks used in conversation, they give the language an explosive character quite unlike any other in the world. The Andamanese are the only other Pigmies who have a language of their own. It resembles the Tasmanian in being a complicated system of prefixes and suffixes. Man says that the general principle of its construction is agglutination pure and simple. The Semang, though retaining a few elements of their original language, commonly use that of their neighbours, the Sakei and other races of the Malay Peninsula. The Aetas speak the Malay-Polynesian languages of the various tribes with which they come in contact such as the Tagals and Vicols. Little is known of the language of the New Guinea Pigmies, but they generally understand their Papuan neighbours.

Counting is met with in its most primitive form amongst the Pigmies. I can find nothing under this head as regards the Equatorial race, except that Von Luschan got his Pigmies to count up to ten in Bantu. For five and ten they used the Bantu word for hand, a common method in Central Africa. The Bushmen have words to express one, two, and three, and count further up to ten by combining these, raising one hand for five and two for ten. The Andamanese only enumerate one and two, after this holding up one finger after another and saying this, and this, and this, until they come to ten, when they show both hands and say "all." They have in addition a complicated ordinal system quite peculiar to themselves. The Semang seem, as regards enumeration, to have reached the same stage as the Andamanese and the Negritos. As regards the New Guinea Pigmies we have no details, but Williamson tells us that the Mafulu have words for one and two, and, combining these, count up on their fingers and toes to twenty. When a large number has to be counted several individuals have to contribute their digits (*vide* "Mafulu Mountain People of British New Guinea," p. 227).

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1912—Williamson, R. W., "The Mafulu Mountain People of British New Guinea."
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1922—Vanden Bergh, L. J., "On the Trail of the Pigmies."

ANNUAL REPORT

FOR YEAR ENDED SEPTEMBER 30, 1923.

Professor F. Wood Jones' exploration of the Flora and Fauna of Nuyts Archipelago and the Investigator Group has continued to supply material for record in our "Transactions," the forthcoming volume of which will contain papers of this series by Miss Joan Proctor, Professors F. Wood Jones, T. G. B. Osborn, and J. B. Cleland, and Messrs. E. R. Waite, Arthur M. Lea, N. B. Tindale, and J. G. Wood. Other series which will be continued in this volume are those on "Australian Fungi," by Professor J. B. Cleland and Edwin Cheel; "Additions to the Flora of South Australia," by J. M. Black; "Australian Coleoptera," by A. H. Elston; "Polyplacophora," by Edwin Ashby; and "The External Characters of Pouch Embryos of Marsupials," by Professor F. Wood Jones. It will also include papers on various other subjects by Sir Douglas Mawson, Professors Harvey Johnston, T. G. B. Osborn, and Walter Howchin; Drs. R. S. Rogers, Jefferis Turner, and O. W. Tiegs; and Messrs. J. G. Wood, R. L. Jack, and R. G. Thomas. The volume, which will be published about Christmas, will, both in size and value, fully equal that issued last December.

The expenditure upon printing and publishing has been heavy this year, as in addition to the exceptionally bulky annual volume an Index has been issued which includes all the Society's publications from 1901 to 1920. This Index, together with that issued in 1907, makes it easy to refer to all the subjects dealt with by the Society from 1877 to 1920.

The exhibits at the evening meetings have continued to sustain their interesting character.

The Council has given considerable thought to a revision of the Rules and By-laws of the Society, and has proposed several minor alterations with a view to making them clearer and better adapted to the growth of the Society's work. These were adopted at a special meeting held on September 13, and will be printed in the forthcoming volume.

The continued growth of our Library has now reached a point at which it is impossible without additional shelving to arrange the books in a systematic and convenient way. Representations on this subject were made to the Government through the Board of Governors of the Public Library, etc., some years ago, and the urgency of the case was again pointed out this year, but so far no reply has been received.

During the year the Society was asked to nominate a representative upon an Advisory Committee to deal with the issue of permits by the Commonwealth Government for the export of indigenous animals, and Dr. A. M. Morgan was so nominated, with Mr. Ising as deputy when the former is unable to act.

Our President (Dr. Pulleine) represented the Society upon the Pan-Pacific Scientific Conference recently held in Melbourne and Sydney.

Sir Joseph C. Verco, one of our Vice-Presidents, has been absent on leave for six months attending the celebration of the 800th anniversary of St. Bartholomew's Hospital, London.

Several deaths have occurred in our membership, including those of two Honorary Fellows—J. G. O. Tepper, who was connected with the Society from 1878, and contributed largely to its "Transactions," and Thomas Gill, C.M.G., I.S.O., elected in 1905 in recognition of his long-continued and valuable support. Mr. William Pope, elected Fellow in 1908, and Mrs. H. R. Robinson, elected Associate in 1904, also passed away during the year

Our present membership comprises 7 Honorary Fellows, 4 Corresponding Members, and 98 Fellows.

ROBERT PULLEINE, *President*
WALTER RUTT, *Hon. Secretary*

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Revenue and Expenditure for 1922-23.

	£ s. d.	£ s. d.
To Balance October 1, 1922		838 7 1
" Subscriptions—		
Royal Society	89 10 0	
Field Naturalists' Section	50 1 3	
		139 11 3
" Grants from S.A. Government—		
On Subscriptions	84 2 3	
For Printing Reports and Scientific Investigations	150 0 0	
		234 2 3
" Receipts for use of Room by other Societies	5 13 6	
" Receipts from Authors' Corrections	2 7 6	
" Sale of Publications	3 19 10	
		12 0 10
" Savings Bank Interest	21 17 10	
" Interest transferred from Endowment Fund	178 18 7	
		200 16 5
		£1,424 17 10

	£ s. d.	£ s. d.
By Transactions—		
Printing	371 8 9	
Illustrating	187 14 9	
Publishing	17 8 11	
Index to Proceedings	154 3 8	
		730 16 1
" Grants—		
Field Naturalists' Section	50 0 0	
Scientific Investigations	6 6 0	
		56 6 0
" Library—		
Librarian, Cataloguing, Receiving, and Issuing	36 3 0	
Indexing	10 0 0	
Freight, etc.	0 18 10	
		47 1 10
" Sundries—		
Cleaning and Lighting	4 16 11	
Printing, Postage, Stationery	16 17 11	
Insurance	7 13 8	
Advertising	5 3 8	
		34 12 2
" Balance September 30, 1923—		
Savings Bank of S A.	373 16 2	
Bank of Australasia	182 2 0	
Cash in Hand	0 3 7	
		556 1 9
		£1,424 17 10

Audited and found to be correct.

W. CHAMPION HACKETT, } Hon.
HOWARD WHITBREAD, } Auditors.

B. S. ROACH, Hon. Treasurer.

Adelaide, October 8, 1923.

ENDOWMENT FUND.

(Capital £3,844 6s. 10d.)

	£ s. d.	£ s. d.
1922—October 1.		
To Balance	3,839 18 9	
„ Savings Bank Account	4 8 1	
		3,844 6 10
„ Interest received on Government Stock	178 15 0	
„ Savings Bank Interest	0 3 7	
		178 18 7
		£4,023 5 5

	£ s. d.	£ s. d.
1923—September 30.		
By £2,000 S.A. Govt. Stock at 3½ per cent.	1,997 10 0	
„ £800 S.A. Govt. Stock at 6 per cent. ..	800 0 0	
„ £500 S A. Govt. Consolidated 3 per cent. Stock at cost	292 8 9	
„ £100 S.A. Govt. Stock at 5 per cent. ..	100 0 0	
„ £650 S.A. Govt. Stock at 5½ per cent. ..	650 0 0	
„ Savings Bank Account	4 8 1	
		3,844 6 10
„ Revenue Account		178 18 7
		£4,023 5 5

Audited and found to be correct.

W. CHAMPION HACKETT, } Hon.
HOWARD WHITBREAD, } Auditors.

B. S. ROACH, Hon Treasurer.

Adelaide, October 8, 1923.

DONATIONS TO THE LIBRARY

FOR THE YEAR ENDED SEPTEMBER 30, 1923.

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presented by the respective governments, societies, and editors.

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LIST OF FELLOWS, MEMBERS, ETC.
AS EXISTING ON SEPTEMBER 30, 1923.

Those marked with an asterisk have contributed papers published in the Society's Transactions.

Any change in address should be notified to the Secretary.

Note.—The publications of the Society will not be sent to those whose subscriptions are in arrear.

Date of Election.

HONORARY FELLOWS.

1910. *Bragg, Sir W. H., K.B.E., M.A., D.Sc., F.R.S., Professor of Physics, University College, London (Fellow 1886).
1893. *Cossman, M., 2 Bould Saddi-Carnot, Enghien, France.
1897. *David, Sir T. W. Edgeworth, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S., F.G.S., Professor of Geology, University of Sydney.
1905 *Hedley, Chas., Assistant Curator, Australian Museum, Sydney.
1892. *Maiden, J. H., I.S.O., F.R.S., F.L.S., Director of Botanic Gardens, Sydney.
1898. *Meyrick, E. T., B.A., F.R.S., F.Z.S., Thornhanger, Marlborough, Wilts, England.
1894 *Wilson, J. T., M.D., Ch.M., Professor of Anatomy, Cambridge University, England.

CORRESPONDING MEMBERS.

1913. *Carter, H. J., B.A., Kintore Street, Wahroonga, N.S.W.
1909. *Johncock, C. F., Clare.
1905. Thomson, G. M., F.L.S., 209 Cargill Street, Dunedin, New Zealand.
1908. *Woolnough, Walter G., D.Sc, F.G.S. (Fellow 1902).

FELLOWS.

1895. *Ashby, Edwin, F.L.S., M.B.O.U., Blackwood.
1917. Bailey, J. F., Director Botanic Garden, Adelaide.
1902. *Baker, W. H., F.L.S, King's Park.
1921. Birks, Melville, M.B., B.S., F.R.C.S., Hospital, Broken Hill.
1902. *Black, J. M., 82 Brougham Place, North Adelaide.
1912 *Broughton, A. C., 167 Young Street, Parkside.
1911. Brown, Edgar J., M.B., D.Ph., 12 North Terrace.
1883. *Brown, H. Y. L., 286 Ward Street, North Adelaide.
1916. *Bull, Lionel B., D.V.Sc, Laboratory, Adelaide Hospital.
1923. Burden, Roy L., B.Sc., University of Adelaide.
1921. Burton, R. J., Fuller Street, Walkerville.
1922. Campbell, T., B.D.S., Adelaide Hospital.
1907. *Chapman, R. W., M.A., B.C.E., F.R.A.S., Professor of Engineering and Mechanics University of Adelaide.
1904 Christie, W., King William Street, Adelaide.
1895. *Cleland, John B., M.D., Professor of Pathology, University of Adelaide.
1923. Conrick, John, Nappamerrie, Farina.
1907. *Cooke, W. T., D.Sc., Lecturer, University of Adelaide.
1916. Darling, H. G., Franklin Street, Adelaide.
1887. *Dixon, Samuel, Bath Street, New Glenelg.
1915. *Dodd, Alan P., Prickly Pear Laboratory, Sherwood, Brisbane.
1921. Dutton, G. H., B.Sc., F.G.S., 21 Da Costa Avenue, South Prospect.
1911. Dutton, H. H., B.A., Anlaby.
1902. *Edquist, A. G., Second Avenue, Sefton Park.
1918. *Elston, A. H., F.E.S., "Hatherley," Commercial Road, Unley Park.
1917. *Fenner, Chas. A. E., D.Sc., F.G.S., Education Department, Adelaide.
1914. Ferguson, E. W., M.B., Ch.M., Gordon Road, Roseville, Sydney.
1923. Fry, H. K., D.S.O., M.D., B.S., B.Sc., Glen Osmond Road, Parkside.
1919. Glastonbury, O. A., Adelaide Cement Co., Brookman Buildings, Grenfell Street.
1923. Glover, C. J. R., Stanley Street, North Adelaide.
1904. Gordon, David, 72 Third Avenue, St. Peters.
1880. *Goyder, George, A.M., F.C.S., Gawler Place, Adelaide.
1910. *Grant, Kerr, M.Sc., Professor of Physics, University of Adelaide.
1922. Grant, R. L. T., M.B., B.S., M.R.C.P., University of Adelaide.

Date of Election.

1904. Griffith, H., Hove, Brighton.
1916. Hackett, W. C., 35 Dequetteville Terrace, Kent Town
1922. Hale, H. M., Irish Harp Road, Prospect.
1922. *Ham, William, F.R.E.S., University of Adelaide.
1916. Hancock, H. Lipson, A.M.I.C.E., M.I.M.M., M.Am.I.M.E., Gawler Park, Angaston.
1896. Hawker, E. W., F.C.S., East Bungaree, Clare.
1923. Hill, Florence M., B.S., M.D., University of Adelaide.
1883. *Howchin, Professor Walter, F.G.S., "Stonycroft," Goodwood East.
1918. *Ising, Ernest H., Locomotive Department, S.A. Railways, Mile End.
1912. *Jack, R. L., B.E., F.G.S., Assistant Government Geologist, Adelaide.
1893. James, Thomas, M.R.C.S., 9 Watson Avenue, Rose Park.
1918. Jennison, Rev. J. C., Stirling West.
1910. *Johnson, E. A., M.D., M.R.C.S., 295 Pirie Street.
1910. *Johnston, Professor T. Harvey, M.A., D.Sc., University of Adelaide.
1920. *Jones, F. Wood, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., Professor of Anatomy, University of Adelaide.
1923. Judell, Lester M. W., B.Sc., Jamestown.
1918. Kimber, W. J., 28 Second Avenue, Joslin.
1915. *Laurie, D. F., Agricultural Department, Victoria Square.
1897. *Lea, A. M., F.E.S., South Australian Museum, Adelaide.
1884. Lendon, A. A., M.D., M.R.C.S., Lecturer in Obstetrics, University of Adelaide, and Hon. Physician, Children's Hospital, North Adelaide.
1922. Lendon, Guy A., M.B., B.Sc., M.R.C.P., North Terrace.
1888. *Lower, Oswald B., F.Z.S., F.E.S., Broken Hill, New South Wales.
1922. Madigan, C. T., B.A., B.Sc., University of Adelaide.
1923. Magarey, W. A., LL.B., Pirie Street.
1923. Marshall, J. C., Payneham.
1914. Mathews, G. M., F.R.S.E., F.L.S., F.Z.S., Foulis Court, Fair Oak, Hants, England.
1905. *Mawson, Sir Douglas, D.Sc., B.E., F.R.S., Professor of Geology, University of Adelaide.
1920. Mayo, Herbert, LL.B., Brookman Buildings, Grenfell Street.
1919. Mayo, Helen M., M.B., B.S., 47 Melbourne Street, North Adelaide.
1923. McBride, R. M., J.P., 14 Giles Street, Toorak.
1920. McGilp, John Neil, Napier Terrace, King's Park.
1907. Melrose, Robert T., Mount Pleasant.
1897. *Morgan, A. M., M.B., Ch.B., 46 North Terrace.
1921. Moulden, Owen M., M.B., B.S., Broken Hill.
1913. *Osborn, T. G. B., D.Sc., Professor of Botany, University of Adelaide.
1886. Poole, W. B., 6 Rose Street, Prospect.
1907. *Pulleine, R. H., M.B., 3 North Terrace.
1916. Ray, William, M.B., B.Sc., A.M.P. Chambers, King William Street.
1885. *Rennie, Edward H., M.A., D.Sc., F.C.S., Professor of Chemistry, University of Adelaide.
1911. Roach, B. S., Education Department, Flinders Street.
1919. *Robertson, Professor T. B., University of Adelaide.
1905. *Rogers, R. S., M.A., M.D., 52 Hutt Street.
1869. *Rutt, Walter, C.E., Pembroke Street, College Park.
1891. Selway, W. H., Treasury, Adelaide.
1922. *Samuel, Geoffrey, B.Sc., University of Adelaide.
1920. Simpson, A. A., C.M.G., Lockwood Road, Burnside
1906. Snow, Francis H., National Mutual Buildings, King William Street.
1923. Sprod, M. W., M.B., B.S., Mannum.
1910. *Stanley, E. R., Government Geologist, Port Moresby, Papua.
1922. Sutton, J., Fullarton Road, Netherby.
1923. Thomas, R. G., 5 Trinity Street, St. Peters.
1923. Thomas, J. F., 64 Elizabeth Street, Sydney.
1923. *Tindale, N. B., South Australian Museum, Adelaide
1921. *Tiegs, Oscar W., M.S., D.Sc., University of Adelaide.
1897. *Torr, W. G., LL.D., M.A., B.C.L., Brighton.
1894. *Turner, A. Jefferis, M.D., F.E.S., Wickham Terrace, Brisbane, Queensland.
1878. *Verco, Sir Joseph C., M.D., F.R.C.S., North Terrace.
1914. *Waite, Edgar R., F.L.S., C.M.Z.S., Director, South Australian Museum.
1912. *Ward, Leonard Keith, B.A., B.E., Government Geologist, Adelaide.
1920. Weidenbach, W. W., A.S.A.S.M., "Glencoola," Glen Osmond.
1904. Whitbread, Howard, c/o A. M. Bickford & Sons, Currie Street.
1912. *White, Capt. S. A., C.M.B.O.U., "Wetunga," Fulham.
1920. *Wilton, Professor J. R., D.Sc., University of Adelaide.
1923. *Wood, J. G., B.Sc., University of Adelaide.

Royal Society of South Australia

(INCORPORATED).

Rules

AS AMENDED, 1923.

NAME.

1. The title of the Society is the "Royal Society of South Australia (Incorporated)," hereinafter called the Society.

OBJECTS.

2. The objects of the Society are the promotion and diffusion of scientific knowledge by meetings for the reading and discussion of papers and by other methods.

CONSTITUTION.

3. The Society shall be constituted of the persons who are enrolled as members. They shall be classed as Fellows, Honorary Members, Corresponding Members, and Associates.

4. Honorary Members must be persons distinguished for their attainments in science, or who have rendered signal service to the Society.

5. Corresponding Members must be persons who reside more than ten miles from the General Post Office, Adelaide, and who, by furnishing papers or otherwise, have promoted the objects of the Society.

6. Men or women may be Associates; the male Associates must be under the age of 21 years.

7. Associates shall at any time be entitled to become Fellows upon their written application to the Council, and payment of the prescribed subscription payable by Fellows.

8. Honorary Members, Corresponding Members, and Associates shall be entitled to all the privileges of Fellows, except that they shall not debate or vote upon questions dealing with the management of the Society's business.

ELECTION OF MEMBERS.

9. Every candidate for membership must be nominated on the prescribed form by two Fellows, one of whom must attest from personal knowledge of the candidate.

10. The nomination paper shall be lodged with the Secretary, and shall be submitted to the Council and the Society at their first following meetings, and the election shall be held at the next subsequent meeting (not being a special meeting) of the Society.

11. No person shall be eligible for election as an Honorary Member unless recommended by the Council.

12. Elections shall be by ballot, one negative in six excluding.

13. A candidate who has been so excluded shall not be eligible to be again nominated within one year of such exclusion.

14. Every person elected shall have immediate notice thereof transmitted to him by the Secretary, accompanied by a copy of the Rules and By-Laws, and shall be enrolled as a member.

Cession of Membership.

15. A member may resign his membership at any time by notification in writing to the Secretary, and shall thereupon cease to be a member, but shall not thereby be released from any indebtedness to the Society.

16. If any Fellow or Associate whose subscription shall be more than twelve months in arrear shall fail to pay the same after application in writing by the Treasurer, the Council may cancel his membership, and he shall thereupon cease to be a member.

Restoration.

17. The Council may, upon such terms as it shall think fit, re-enrol as a member any person who shall have ceased to be a member.

Management.

18. The management of the affairs and funds of the Society, and the custody of its property, shall, subject to any by-laws for the time being regulating or prescribing conditions as to the same, be vested in a Council, composed of a President and such other officers and members as may be prescribed, who shall be elected and hold office for such periods as may be prescribed.

President.

19. The President shall if in attendance preside at all meetings of the Council or Society. In the absence of the President, his duties shall be carried out by such other officer or person denoted or elected in manner prescribed.

Seal and Sealholder.

20. The Common Seal shall have the name of the Society inscribed upon it, and shall be held by the Secretary, who shall for all legal purposes be deemed to be the sealholder.

The Council shall have power to use the seal in the execution of any powers hereby invested in it or otherwise in relation to the affairs or business of the Society. The seal shall not be used except by the authority of the Council. The Secretary and at least two other members of the Council shall sign every instrument to which the seal is affixed.

Meetings of the Society.

21. A meeting of the Society, to be called the Annual Meeting, shall be held in the month of October in every year upon a day and at a place to be appointed by the Council.

22. At the Annual Meeting the Council shall submit a report and duly audited balance-sheet, and the meeting shall fill all vacancies among the officers and the members of Council for the ensuing year, and transact any other business of which due notice has been given.

23. The Council may convene an ordinary meeting of the Society at any time.

24. The Council may at any time, and shall upon the requisition in writing of seven Fellows, specifying the purpose for which the meeting is required, convene a special meeting of the Society. The special business for which the meeting has been convened, and none other, shall be transacted at such meeting.

25. Seven Fellows shall be a quorum. If at any meeting a quorum is not present within thirty minutes after the hour of meeting, the meeting shall stand adjourned to a day and time to be appointed by those present, not being earlier than seven days. At the adjourned meeting the Fellows then present may proceed to business, although fewer than the prescribed quorum may be present.

26. At least three days' notice of every meeting or adjourned meeting and of the principal items of business to be transacted thereat shall be given to the members resident in South Australia by circular, or in such manner as may be prescribed.

AUDITORS.

27. Two persons, not being members of the Council, shall be chosen at some meeting of the Society prior to the Annual Meeting in each year to audit the accounts and balance-sheet for the then current year.

BY-LAWS.

28. The Council may make, repeal, alter, or vary by-laws not inconsistent with these rules for the effective carrying out of the objects and purposes of the Society; but no such by-law, repeal, alteration, or variation shall be valid unless approved by a majority of the Fellows voting at a meeting of the Society of which due notice has been given.

ALTERATION OF RULES.

29. The Society may by a majority of at least two-thirds of the Fellows present at an Annual Meeting, or at a special meeting duly convened for the purpose, make any rule or repeal, alter, or vary any existing rule.

30. In the construction of the rules of the Society, unless the subject or context requires a different meaning:—

"By-law" shall include regulations under "The Public Library, Museum, and Art Gallery and Institute Act, 1909," or any other Act or power enabling the Society to make regulations.

"Prescribed" means prescribed by by-law.

Words denoting the singular number only shall be deemed to include the plural and vice versa. Words denoting the masculine gender shall be deemed to include the feminine

31. All rules and by-laws of the Society heretofore in force are hereby repealed.

By-Laws.

I.—NOMINATION PAPER.

The Nomination Paper referred to in Rules 9 and 10 shall state the full name, address, and occupation of the candidate, and the class of membership for which he is nominated. When elected, the date of his election shall be entered upon the Nomination Paper, and signed by the chairman of the meeting.

II.—COUNCIL.

1. The Council shall consist of twelve (12) Fellows, comprising a President, two Vice-Presidents, a Treasurer, an Editor, a Secretary, and six other Fellows. Any four members of the Council shall form a quorum.

2. At each Annual Meeting all officers except the Editor and the Secretary shall retire, as also shall two other members of the Council, but all retiring members shall be eligible for re-election. The non-official members to retire shall be those who have been longest in the Council since their last election, or in case of equal tenure, the retirement shall be decided by lot.

3. The vacancies on the Council shall then be filled by election, which shall be by ballot, if so required by any Fellow.

4. The Editor and Secretary shall hold office during the pleasure of the Society.

5. The Secretary shall keep a record of attendance of members at all meetings of the Council and present the same at the Annual Meeting held in the month of October in each year.

6. If any member of the Council absents himself for the period of three months from all the meetings of the Council, held during such period, without the permission of the Council, granted by resolution of the Council before the expiration of such period, his position, as a member of the Council, shall become vacant.

7. Every casual vacancy in the Council shall be filled at the next meeting of the Society (by ballot if demanded by any Fellow).

8. Any matter within the general powers of management of the Council may be submitted to the Society in the following manner.—

(a) If referred to the Society by resolution of the Council; or

(b) If notice of motion in writing referring to such matter be given to the Secretary by two Fellows.

9. In either case, at the next meeting of the Society the Fellows who have given notice, or failing them (or if the matter be referred by the Council), any Fellow may move. The resolution (if any) of the meeting shall be binding on the Council, *provided, however,* that such resolution shall not prejudice or affect anything authorized and done by or on behalf of the Council relating to such matter, if the same be done prior to the receipt of notice of motion by the Secretary.

III.—Subscriptions

1. The annual subscription of a Fellow shall be one guinea.

2. A Fellow may at any time compound for future annual subscriptions, exclusive of that for the current year, by the payment of fifteen guineas.

3. Associates shall subscribe five shillings per annum

4. All subscriptions shall be payable in advance immediately after the Annual Meeting, or on receipt of notice of membership, as the case may be, to the Treasurer, who shall give a receipt on a printed form for the sum received.

5. The financial year shall extend from October 1 to September 30. Membership for the whole or any part of any financial year shall entail the payment of the subscription for that year, and shall entitle the member to the receipt of any publications issued free to members during that year.

IV.—Meetings of the Society

1. Meetings shall be held on the second Thursday in each month, from April to November, at 8 p.m., in the Society's Rooms, unless the Council shall otherwise decide. Each meeting shall be convened by circular posted to the last known address of the members resident in the State. The circular shall state the subjects to be brought before the Society, the names of candidates for membership, and any notices of motion.

2. In the absence of the President, one of the Vice-Presidents shall take the chair; and in the event of the absence of all of the above the members shall elect a Chairman.

3. The business shall be transacted in the following order, unless it be specially decided otherwise by the meeting:—

(a) Reading and confirmation of the minutes of last meeting.
(b) Election of Members.
(c) Nomination of candidates for membership.
(d) Consideration of motions of which notice has been given.

(e) Reading of notices of motions for subsequent meetings.
(f) Consideration of any special matters which members may desire to bring forward, subject to the approval of the Chairman obtained before the commencement of the meeting.
(g) Any other business brought forward by the Council.
(h) Papers notified in the Circular.
(i) Exhibits.

V.—Papers.

1. No paper which has not been previously approved by the Council shall be brought before the Society.

2. Every paper brought before the Society shall be immediately delivered to the Secretary.

3. The Council shall at its next or at a subsequent meeting decide whether such paper will be published.

4. If the Council decides to publish the paper in whole or in part, it and all copyrights thereof shall become the property of the Society, such copyrights to include all plates, maps, diagrams, and photographs reproduced in illustration of the paper; and all blocks used in such reproductions shall be the property of the Society. All manuscripts and original illustrations must be returned to the Editor with the corrected proofs.

5. All matter used in illustration of papers (whether photographs, prints, negatives, or drawings) remains the property of the authors. The illustrations shall be returned to the Secretary by the printer on publication of the volume and shall be kept by him in safe custody for one year, unless previously claimed by the author. After the expiration of one year they may be disposed of as the Council shall direct.

6. If the Council decides not to publish a paper either in whole or in part, the same shall be returned to the author, if he so desires.

7. All papers and other contributions published by the Society shall be subjected to editing by the Editor.

8. The author of any paper published by the Society shall be entitled to receive free of cost 25 copies of the same, and to obtain additional copies (not exceeding 75, unless the Council shall determine otherwise) upon paying the extra cost thereof. Every such copy shall include a statement that it is taken from the publications of the Society.

9. All contributions and excerpts intended for publication by the Society shall be clearly typed or written on one side of the paper only, and in accordance with the "Suggestions for the Guidance of Authors" published by the Society, ready for the printer.

10. A proof shall be submitted (if possible) to the author, who shall be allowed to make any slight amendments without cost, but if the corrections are excessive they must be paid for by him.

11. In order to secure correct reports, all papers and other contributions laid before the Society must be accompanied by short abstracts.

VI.—Sections.

1. With the consent of the Council, Sections may be formed in connection with the Society for the special study of particular branches of natural or applied science.

2. Such Sections shall consist of:—

(a) Members of the Society who join the Section and pay an annual subscription to the Section.
(b) Other persons who have been duly elected to the Section and who pay its annual subscription.

3. A member of the Society who joins any Section shall not be required to pay an entrance-fee, and the annual subscription paid by him shall not exceed one-half of that paid by non-members of the Society.

4. Each Section shall elect its own Committee of Management.

5. The President and Vice-Presidents of the Society for the time being shall be ex-officio members of the Committee of Management of all Sections.

6. The rules and regulations for the management of Sections shall not have effect until they have been formally approved by the Council of the Society.

7. Subscribers to the Sections shall have access to the library of the Society, subject to such conditions as may be imposed by the Council.

8. The Committee of Management of each Section shall, on or before September 30 of each year, furnish to the Council of the Society an annual report of the proceedings of the Section and its balance-sheet for publication (subject to the approval of the Council) in the Society's annual volume. A copy of such report and balance-sheet shall be given to each member of the Section unless it publishes its own report.

9. Sections shall be allowed the use of the Society's room at such times as may be approved by the Council.

10. All subscriptions received by any Section shall be paid to the Treasurer of the Society on or before September 15 in each year.

11. Grants of money out of the general funds of the Society may be made by the Council to any Section.

VII.—Regulations for the Election of a Member of the Board of Governors of the Public Library, Museum, and Art Gallery of South Australia, pursuant to "The Public Library, Museum, and Art Gallery and Institute Act, 1909."

1. At a meeting in October the Council shall elect one member of the Board; such election shall be by ballot, if so required by any member.

2. No person shall be elected unless he is at the time of his election a member of the Society, nor shall be continue to hold office as such member of the Board if he ceases to be a member of the Society.

3. The elected member shall hold office until the election of his successor, and shall then retire, but may be re-elected.

4. Every casual vacancy shall be filled at the next meeting of the Society (by ballot if demanded by any Fellow).

5. The result of each election shall be certified to His Excellency the Governor under the hand of the President.

6. The elected member shall be deemed to be the representative of the Society upon the said Board, and shall (subject to his duties to the Board) report to the Council all matters concerning the Society which may be dealt with by the Board, and shall make such representations on behalf of the Society as the Society or the Council may from time to time direct.

Signed and Sealed at a special meeting of the Council of the Royal Society of South Australia (Incorporated) held on the eighth day of October, 1923.

Robert Pulleine, *President.*
Walter Rutt, *Hon. Secretary.*
B. S. Roach, *Hon. Treasurer.*

APPENDIX.

FIELD NATURALISTS' SECTION

OF THE

Royal Society of South Australia (Incorporated).

FORTIETH ANNUAL REPORT OF THE COMMITTEE.

FOR THE YEAR ENDED SEPTEMBER 24, 1923.

The Committee has pleasure in presenting the Fortieth Annual Report.

MEMBERSHIP.—Last year the membership was 183. Depletion of our ranks by deaths and resignations during the twelve months amounted to 27. New members elected were 29, thus making a total of 185.

OBITUARY.—We are sorry to have to record the death of Mr. J. G. Ashton, who was one of our earliest members, and who took a keen interest in Nature study.

LECTURES.—We are greatly indebted to the Lecturers upon whom we depend for maintaining interest in the Section. Lectures were given as follows:—"Botany for Beginners," by Mr. J. M. Black; "Our Wattles," by Mr. A. J. Campbell; "Aquatic Life," by Mr. H. M. Hale; "Rock Study," by Sir Douglas Mawson, D.Sc.; "Nature Photography," by Messrs. B. Beck, A. J. Morison, J. F. Bailey, H. M. Hale, P. H. Williams, E. A. S. Thomas, W. H. Selway, W. Rosser and E. H. Ising; "Flora and Fauna of trip to Darwin by Motor," Capt. S. A. White, C.M., B.O.U.; "Tasmanian Scenery," by Dr. R. H. Pulleine; "Native Stone Implements," by Dr. A. M. Morgan; "Univalve Molluscs," by Mr. W. J. Kimber; "Fungi Specimens," by Prof. J. B. Cleland, M.D.; "Life History of some Parasites," by Prof. T. Harvey Johnston, M.A., D.Sc.; "A Trip to Groote Eylandt, Gulf of Carpentaria," by Mr. N. B. Tindale.

EXCURSIONS.—The leaders of the excursions have done good service to the Section The subjects have been as follows:—Botany, Gum Trees, Swamp (Tidal) Flora, Ornithology, Sheoaks, Physiography, Fungi, Conchology, Shore Life, Entomology, Dredging. The trips have been made by train, tram, and charabanc, the latter giving opportunity for getting away from the beaten track.

FLOWER SHOW, 1922.—The annual Flower Show was held on October 13 and 14, in the Institute Building, and proved to be a successful fixture. The Public Schools contributed largely to its success, and kindred Societies in the other States sent splendid exhibits. The credit balance amounted to £16 18s. 5d.

EXHIBITS.—A great number of interesting exhibits have been shown by members at the meetings, and the Committee hopes that this subject will receive greater prominence in the coming year.

GEOGRAPHICAL DISTRIBUTION OF NATIVE PLANTS IN SOUTH AUSTRALIA.—A sub-committee has been formed, and it is the object of the members to conduct a "Plant Survey of South Australia." To carry this out it will be necessary

to get plant specimens. It is hoped that members going on holidays in the country will collect plants, and that all who have friends in any part of the State will enlist their help in obtaining and forwarding specimens. By this means a Field Naturalists' Herbarium will be formed. Eight keepers and many assistants have been appointed to take charge of it. Much assistance has been given by Professors T. G. B. Osborn, D.Sc., and J. B. Cleland, M.D. It is proposed to amalgamate the "Vernacular Plant Names Committee" with the above.

"THE SOUTH AUSTRALIAN NATURALIST."—Our journal has been published quarterly as usual, and the Editor, Mr. Wm. Ham, F.R.E.S., has maintained the quality of articles of the standard set by the first Editor, Dr. C. Fenner, F.G.S. Original articles have been contributed by Messrs. Edgar R. Waite, F.L.S., A. M. Lea, F.E.S., E. H. Ising, Wm. Ham, F.R.E.S., A. J. Morison, Prof. J. B. Cleland, M.D., H. M. Hale, and W. J. Hosking. The issue last month (August, 1923) completed the fourth volume.

EXCHANGES.—"The Victorian Naturalist," "The Australian Naturalist" (Sydney), "The Queensland Naturalist," "The Geelong Naturalist," "The S.A. Ornithologist," "Transactions of the Royal Society of South Australia," "Illustrated Catalogue of the Fishes of South Australia," "National Herbarium of Victoria," Smithsonian Institution, Washington, D.C., U.S.A.

NEWSPAPER REPORTS.—We are much indebted to the daily papers for the splendid reports of our meetings and excursions.

EXPORTATION OF NATIVE FAUNA.—Prof. J. B. Cleland was elected on an Advisory Committee formed in Adelaide to consult with the Commonwealth Government in regard to this matter. Mr. Edwin Ashby was appointed deputy.

Thanks are due to those who so kindly opened their gardens to the inspection of members on various occasions during the year.

(Signed) WM. HAM, *Chairman.*

ERNEST H. ISING, *Hon. Sec.*

THIRTY-FOURTH ANNUAL REPORT OF THE NATIVE FAUNA AND FLORA PROTECTION COMMITTEE.

FOR THE YEAR ENDED SEPTEMBER 20, 1923.

Three meetings were held during the year.

A report having been sent to the Committee that shooting was taking place on the Baroota Reservoir, a letter was written to the Hydraulic Engineer on that case, and at the same time he was asked as to the position with regard to other reservoirs under the supervision of the Water and Sewers Department. His reply was, "That the shooting of birds and other native fauna on the Reservoirs' Reserves by the public is not permitted. Shags and other birds taking the fish in some of the reservoirs are shot by the caretakers."

The proposal to form a sanctuary in the Flinders Range between Wirrabara and Port Germein for kangaroos and euros was being considered. The delay was caused by a fire having occurred in the Wirrabara country.

A proposal to form a sanctuary eight miles from Mount Gambier of the Forest Reserve of 8,000 acres, to which a further 4,000 acres should be added

by purchase, is still in abeyance. The State Minister is favourable to the project, but the purchase of the additional 4,000 acres requires to be passed by Parliament. The whole land is of a scrubby nature, with sheoaks and bracken thereon.

The complaint about the massacre of 80 seals on Pearson Islands turned out to refer to an old occurrence, and not a fresh slaughter, as at first thought.

A protest was made by the Committee to the Commonwealth Minister of Customs against the shipment of Australian birds by the "Medic," and a reply was received that that particular shipment had been allowed because it was in fulfilment of orders received before March 29 last, and the specimens were collected before that date. In answer to that, a request was made to the Minister to prohibit the export of Australian birds in the future.

Enquiry was made by the District Clerk of Minlaton as to the possibility of successfully introducing kookaburras to a reserve in that town, which has some big trees and is about half a mile long and a street wide. The members doubted the success of such an effort on account of the smallness of the area.

It was reported that Messrs. Pearce Bros., Yelland, and Bowman (of Campbell House) had made their lands on Lake Alexandrina, which extend from Reedy Point to Point Sturt to Hindmarsh Island—in all about 20 miles—sanctuaries as regards the bird life thereon.

In response to a request from the Customs and Excise Office, Capt. S. A. White was nominated for appointment on the Advisory Committee for this State *re* the Exportation of Birds and Animals, with Mr. W. Champion Hackett to act in the nominee's absence.

Flinders Chase.—The Chairman reported that the Government had purchased the Rocky River Station and added it to the Chase, and that Mr. May had been engaged to act as Ranger on the Chase.

J. Sutton, *Hon. Secretary.*

September 19, 1923.

FIELD NATURALISTS' SECTION OF THE ROYAL SOCIETY.

Statement of Receipts and Expenditure for Year ended September 30, 1923.

GENERAL ACCOUNT.

Receipts	£	s.	d.	Expenditure	£	s.	d.
By Balance Brought Forward	10	16	1	To Printing	45	6	3
„ Profit from Wild Flower Show, 1922	16	18	5	„ Postages	14	14	8
„ Members' Subscriptions	50	1	3	„ Hire of Hall	8	18	8
„ Grant from Royal Society	50	0	0	„ Stationery	0	3	9
„ Sale of Badges	0	15	0	„ Library Books	3	11	5
„ Sale of "Magazine"	1	6	10	„ Advertising	1	7	5
„ Bank Interest	1	3	0	„ Carriage	0	3	0
				„ Members' Subs paid to Royal Society	50	1	3
				„ Balance Carried Forward	6	14	2
	£131	0	7		£131	0	7

EXCURSION ACCOUNT.

Receipts	£	s.	d.	Expenditure	£	s.	d.
By Balance Brought Forward	10	18	0	To Hire of Motors	64	10	0
„ Excursion Fares	67	6	6	„ Refreshments	2	1	2
				„ Hire of Dredges	6	10	0
				„ Tips to Sailors	1	0	0
				„ Repairs to Dredge Net	0	4	7
				„ Balance Brought Forward	3	18	9
	£78	4	6		£78	4	6

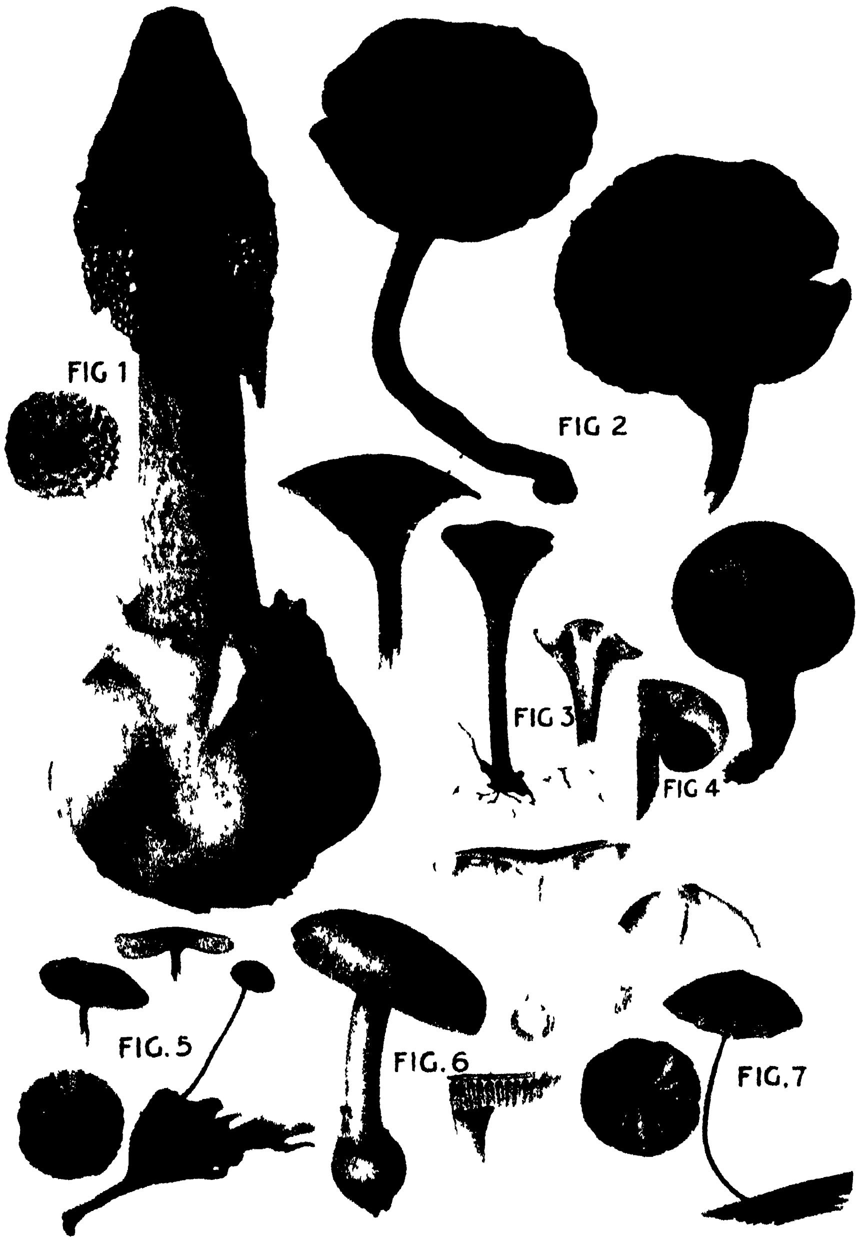
Audited and found correct,

(Signed) WALTER D. REED, F.C.P.A.
A. J. MORISON.

GENERAL INDEX.

[Generic and specific names printed in italics indicate that the forms described are new to science.]

PLATES I. TO XXXVI.



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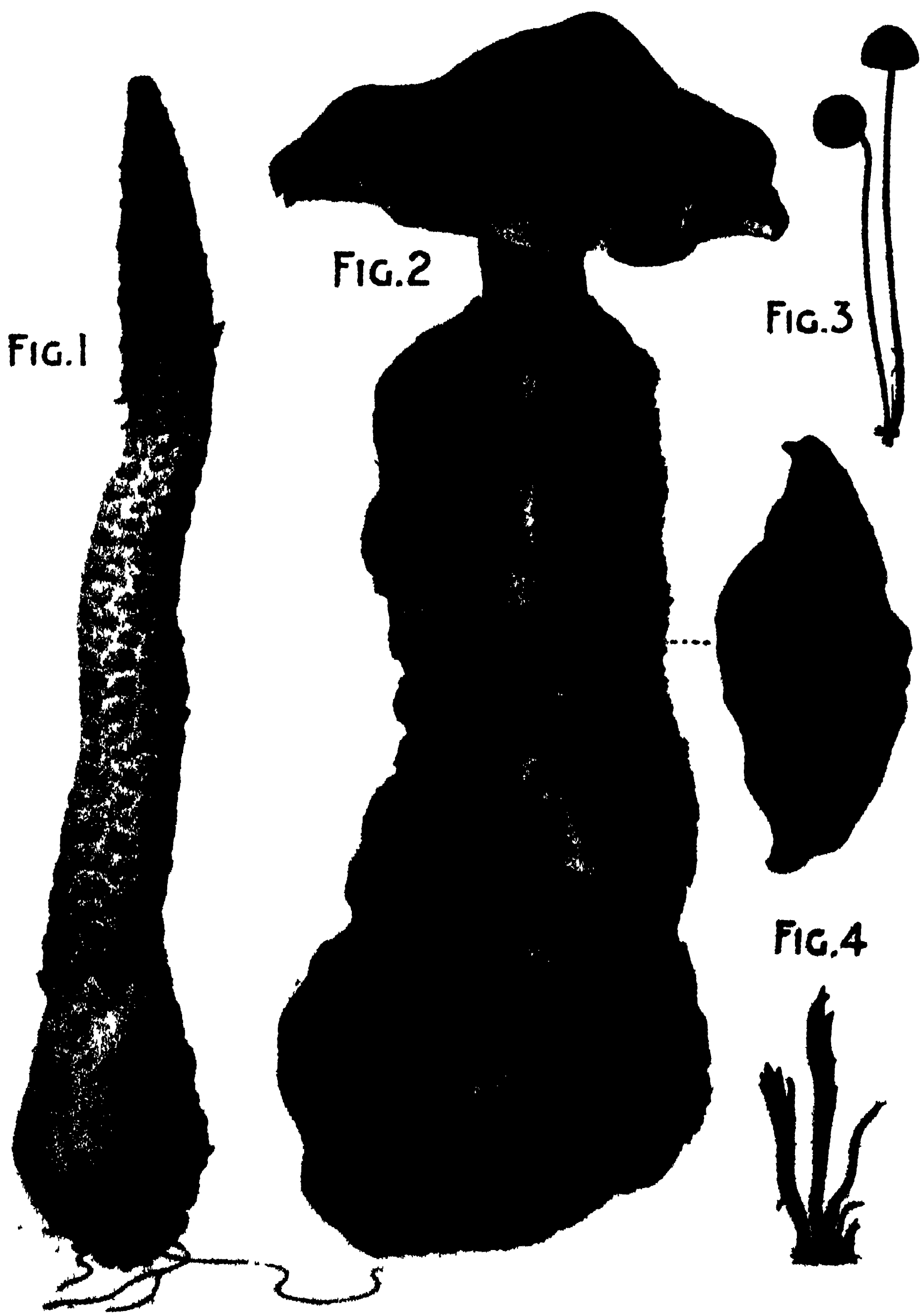

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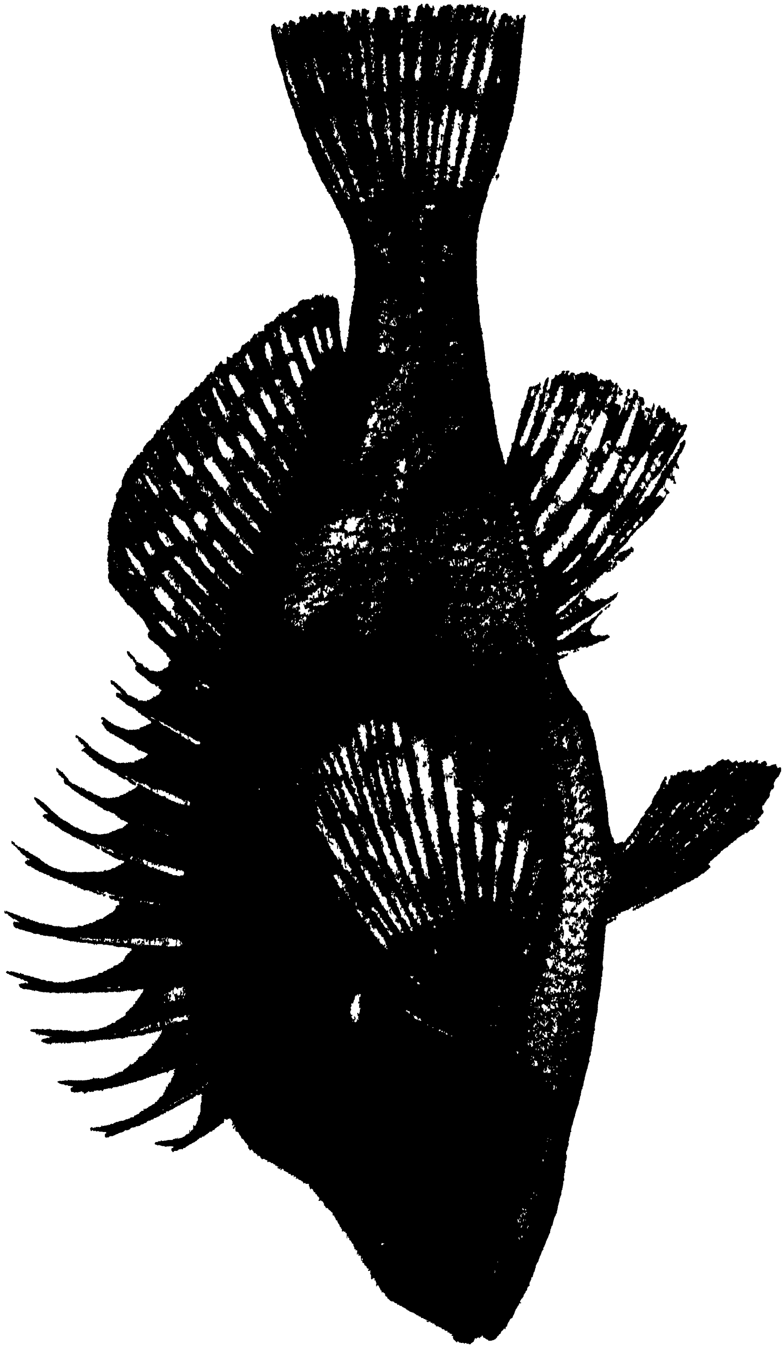

Threpterius maculosus, Richardson

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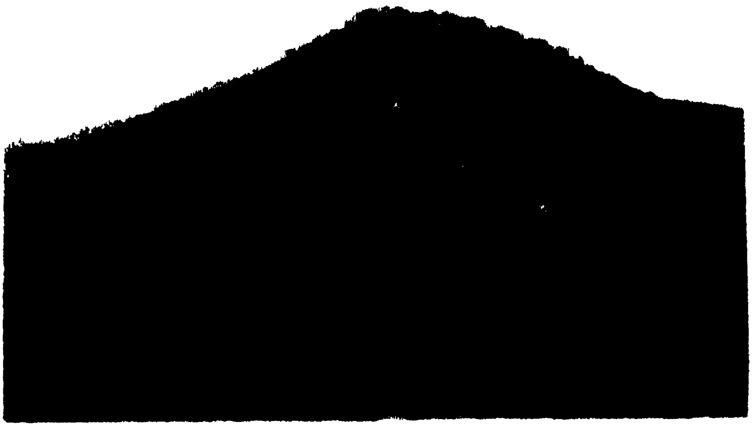

Fig. 1. East Hill from 781 Hill, showing aspect differences. The north face (left) has open *Olearia-Leucopogon* thicket, the south (right) *Casuarina* or *Melaleuca parviflora* woodland.

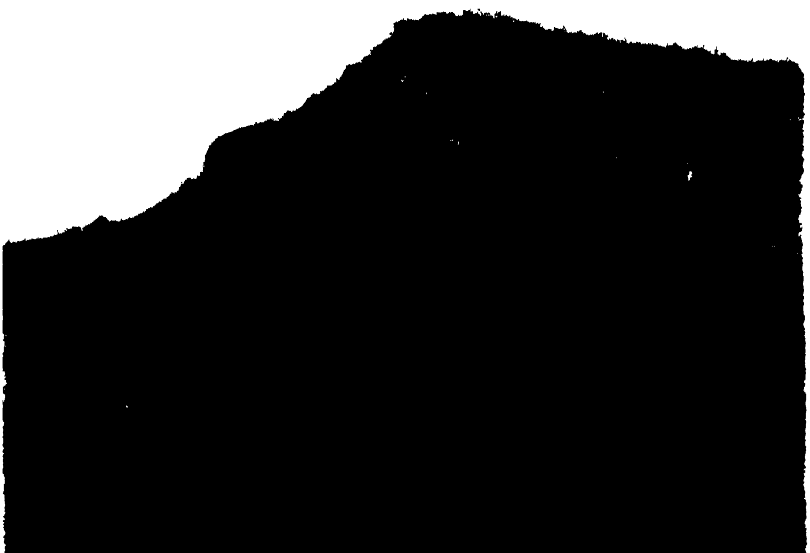

Fig. 2. 781 Hill with bare granite and *Melaleuca parviflora* woodland, succeeded by *Casuarina* at higher levels. Foreground, rubble basin (saline) with *Arthrocnemum* and *Mesem. australe*, and beyond prostrate trees of *M. halmaturorum*.

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Fig. 1. *Casuarina stricta* woodland with *Leucopogon Richei* undergrowth showing sharp transition to bare granite on right.

Fig. 2. Summit of East Hill. *Casuarina* with *Olearia-Leucopogon* below. In foreground is *Rhagodia crassifolia*.

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Fig. 1. *Atriplex paludosum* in foreground, succeeded by *Rhagodia crassifolia* at damper base of hill. *Olearia* and other shrubs on rocky slope.

Fig. 2. *Atriplex paludosum*, with bed of Main Creek beyond occupied by *M. halmaturorum*. In distance is 781 Hill.

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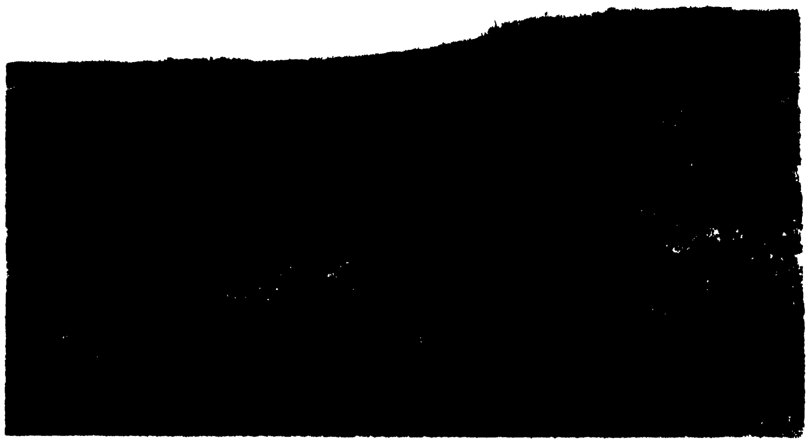

Fig. 1. *Atriplex paludosum*, the darker patches are hollows with *Rhagodia crassifolia*. Main Creek with *M. halmaturorum* in middle distance.

Fig. 2. *Melaleuca parviflora* scrub and *Atriplex paludosum* consocies junction. *Mesem. aequilaterale* on bare patches.

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Fig. 1. *Atriplex cinereum* on shore forming mounds of drift sand.

Fig. 2. Foreground, travertine plateau, *Mesem australe*, *Atriplex cinereum*, etc. Middle Pearson behind.

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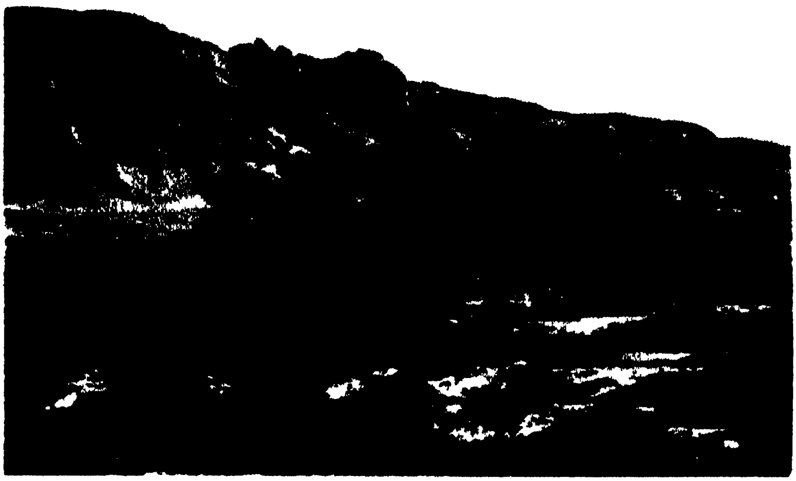

Fig 1 Foreground *Senecio lautus* *Apium* [illegible] behind junction through talus fan with boulder slope (*Olearia* and *Leucopogon* etc)

Fig 2 Bare rubble slope with fresh water drainage, large bushes of *Rhagodia crassifolia*, and some *M parviflora* *Atriplex paludosum* in foreground

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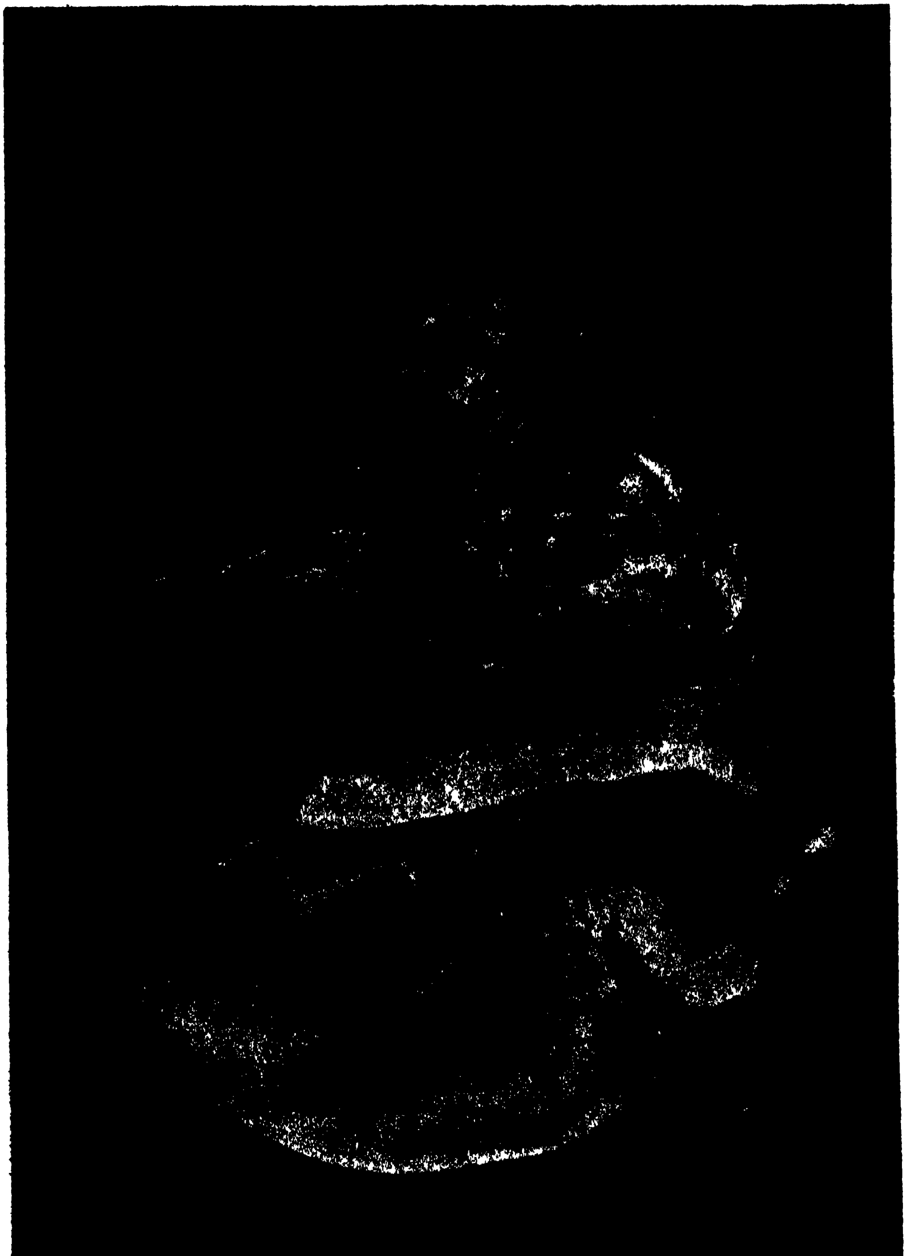

Phascolarctus cinereus.
Pouch young from the Queensland Museum. Slightly enlarged.

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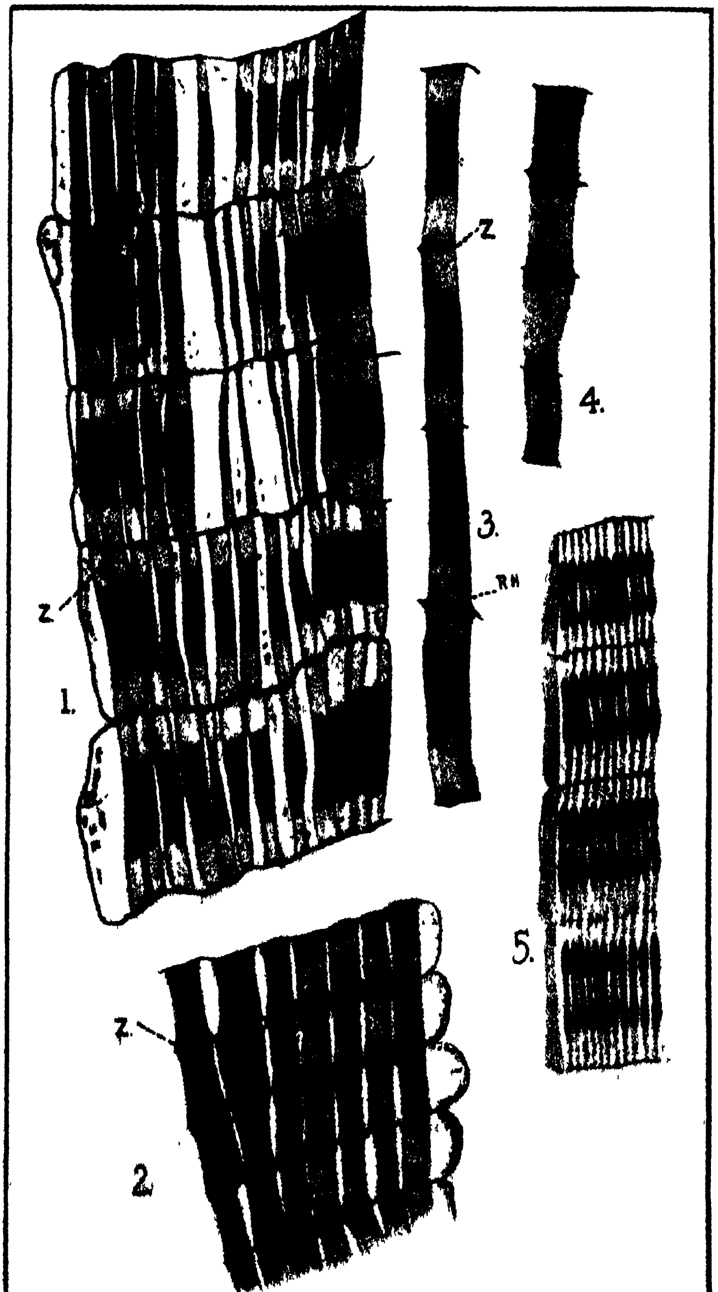

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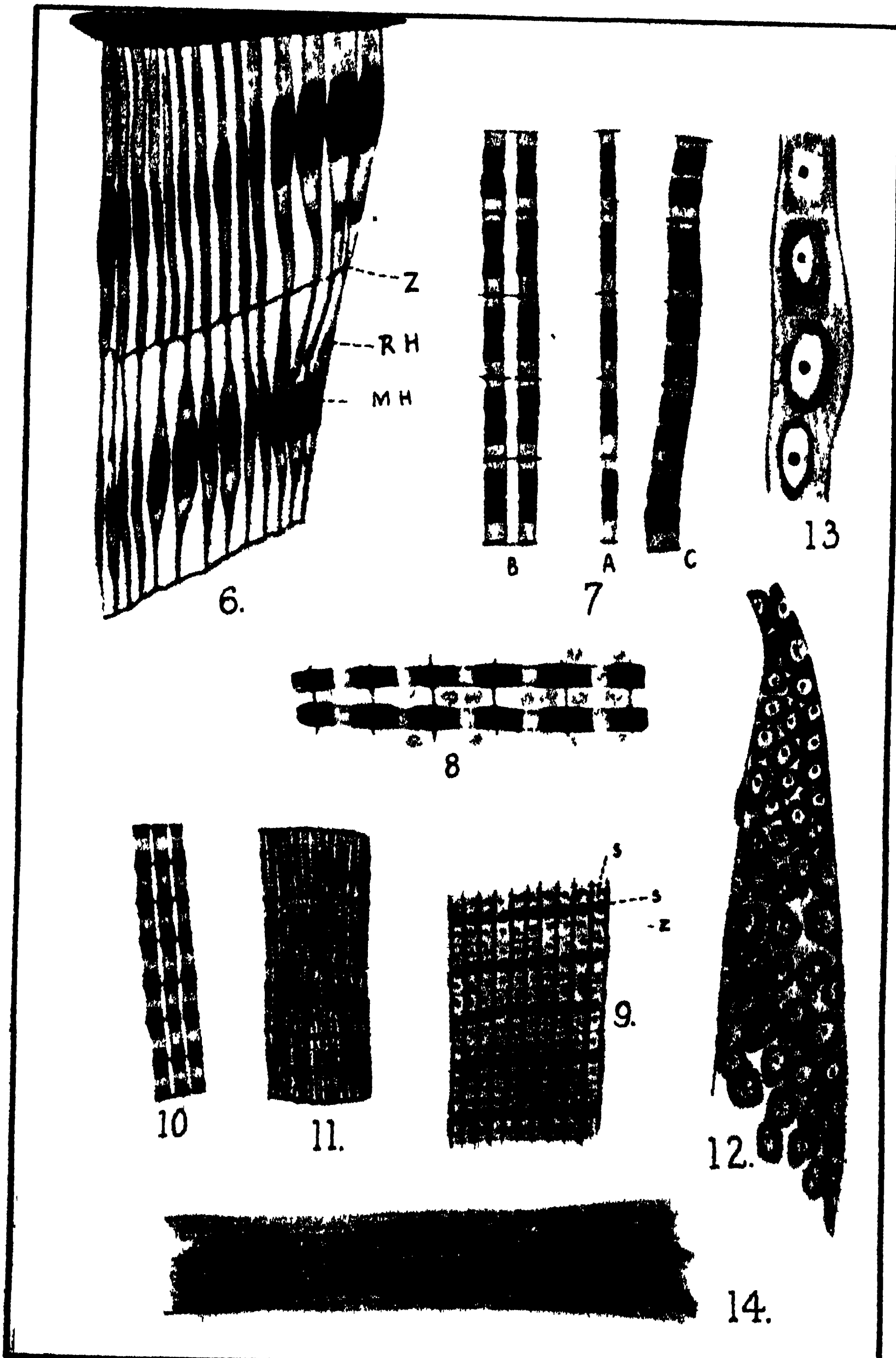

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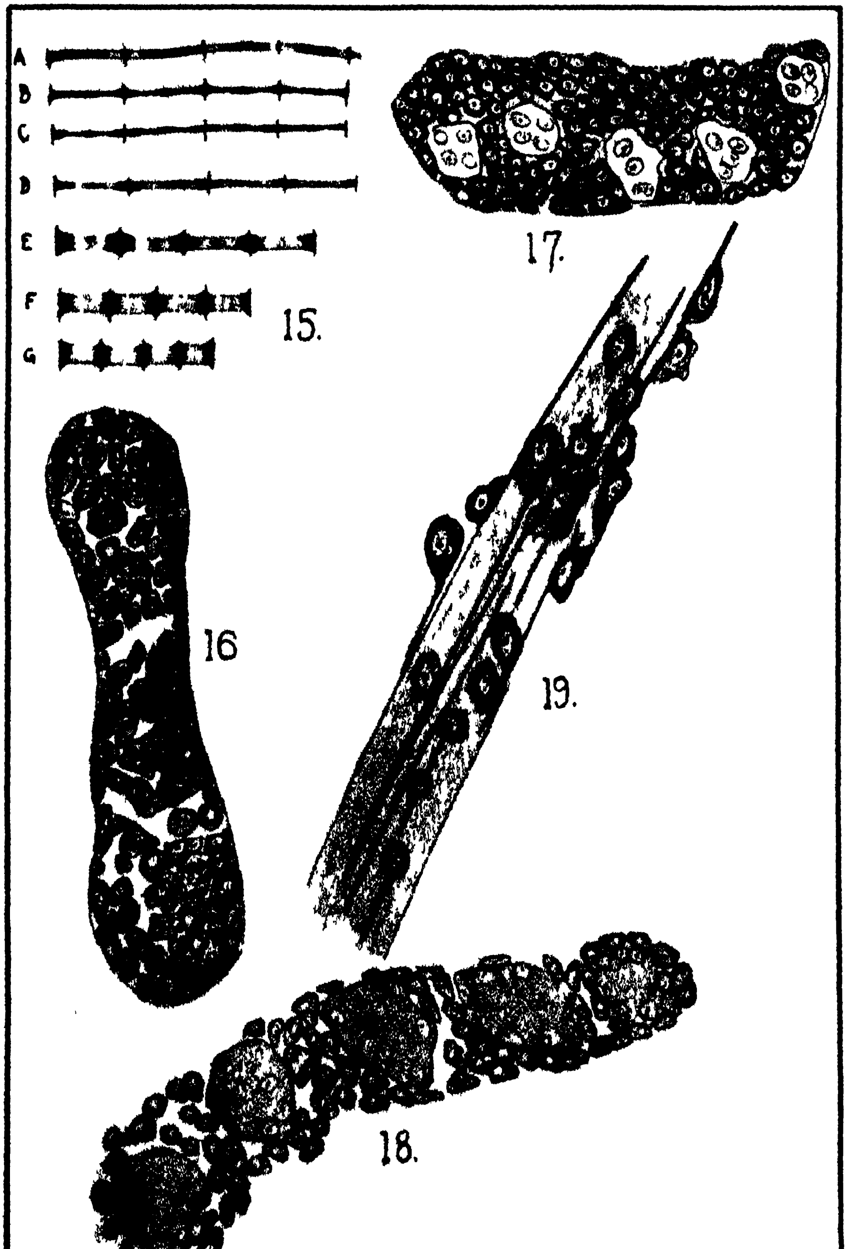

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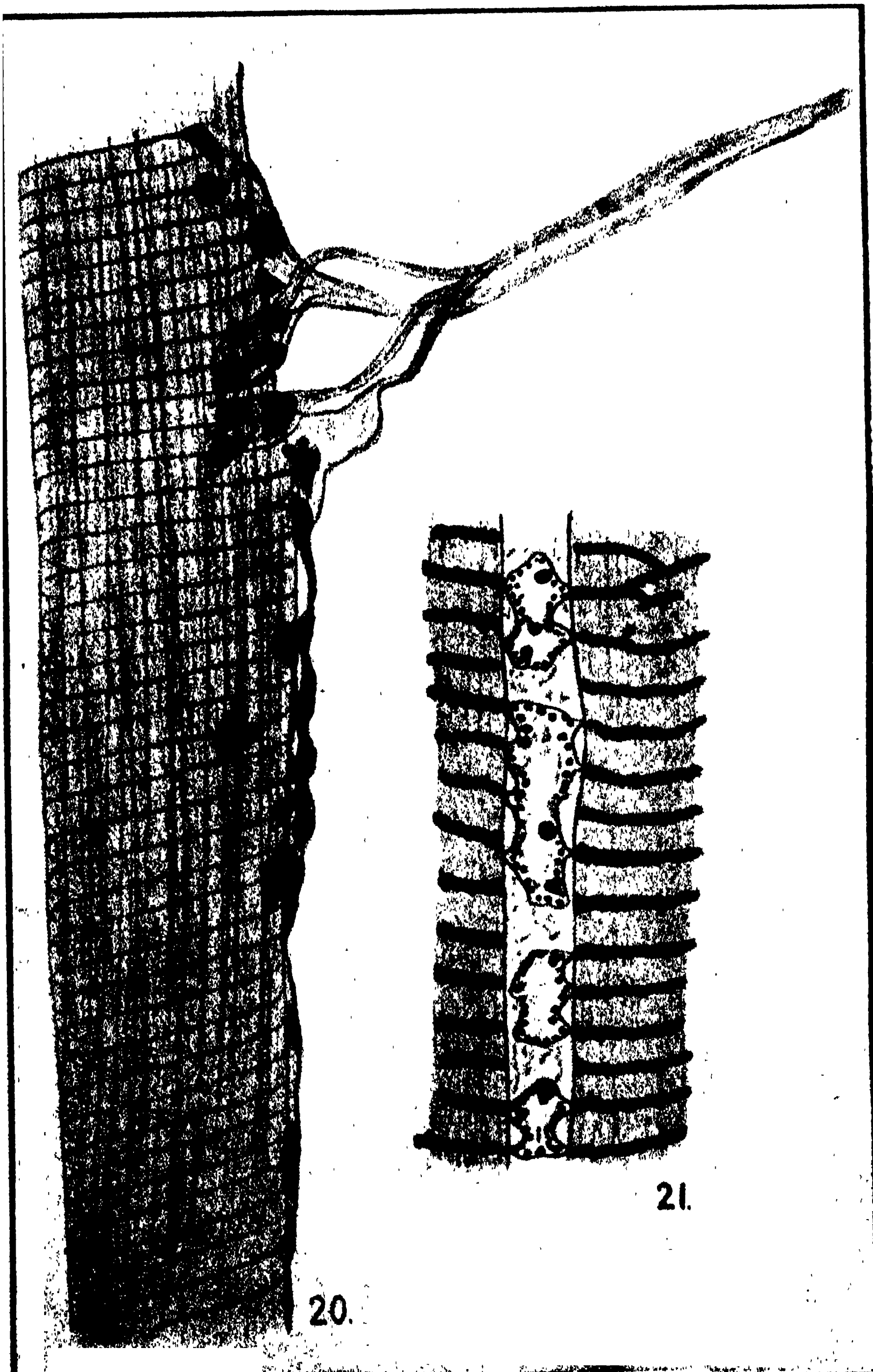

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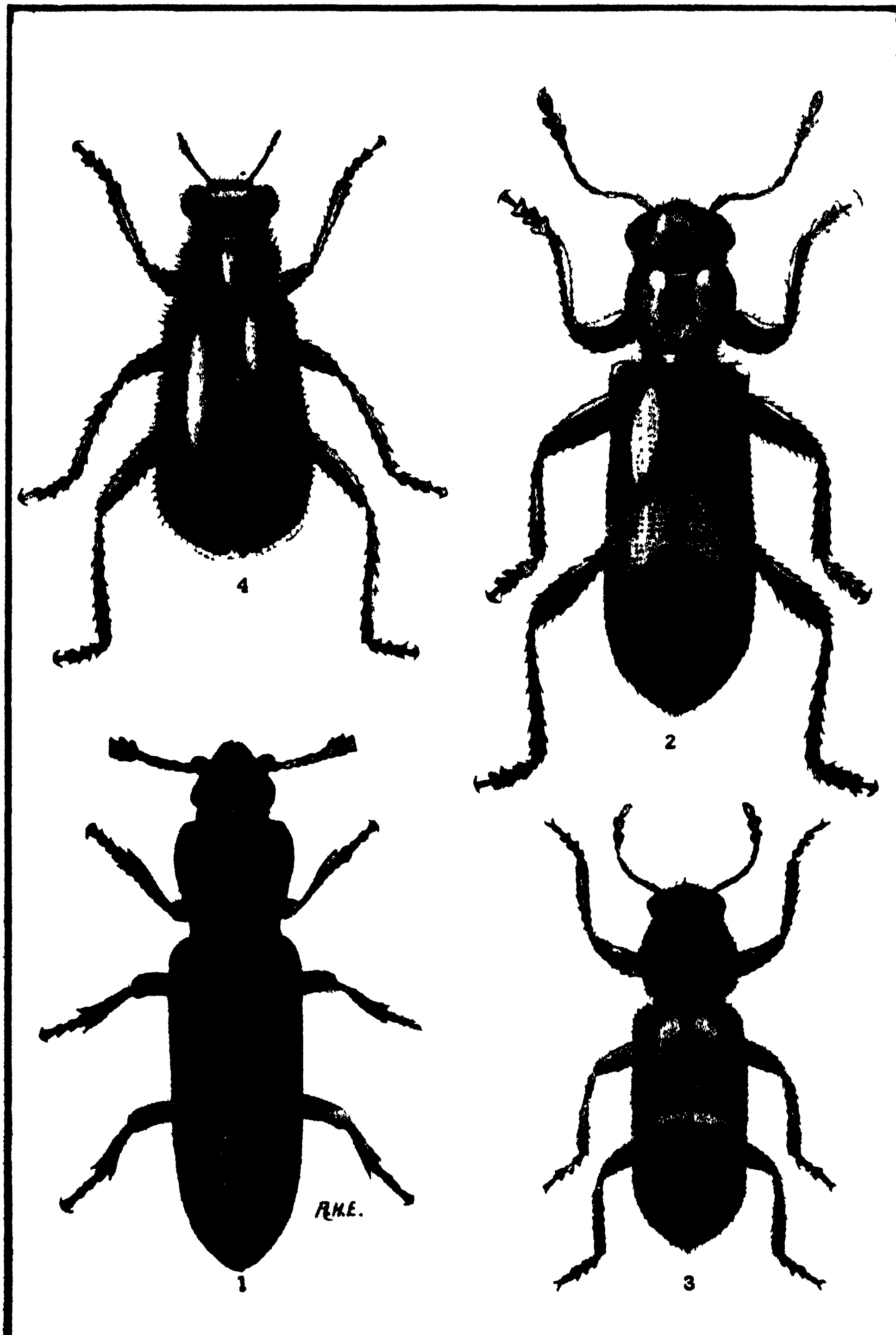

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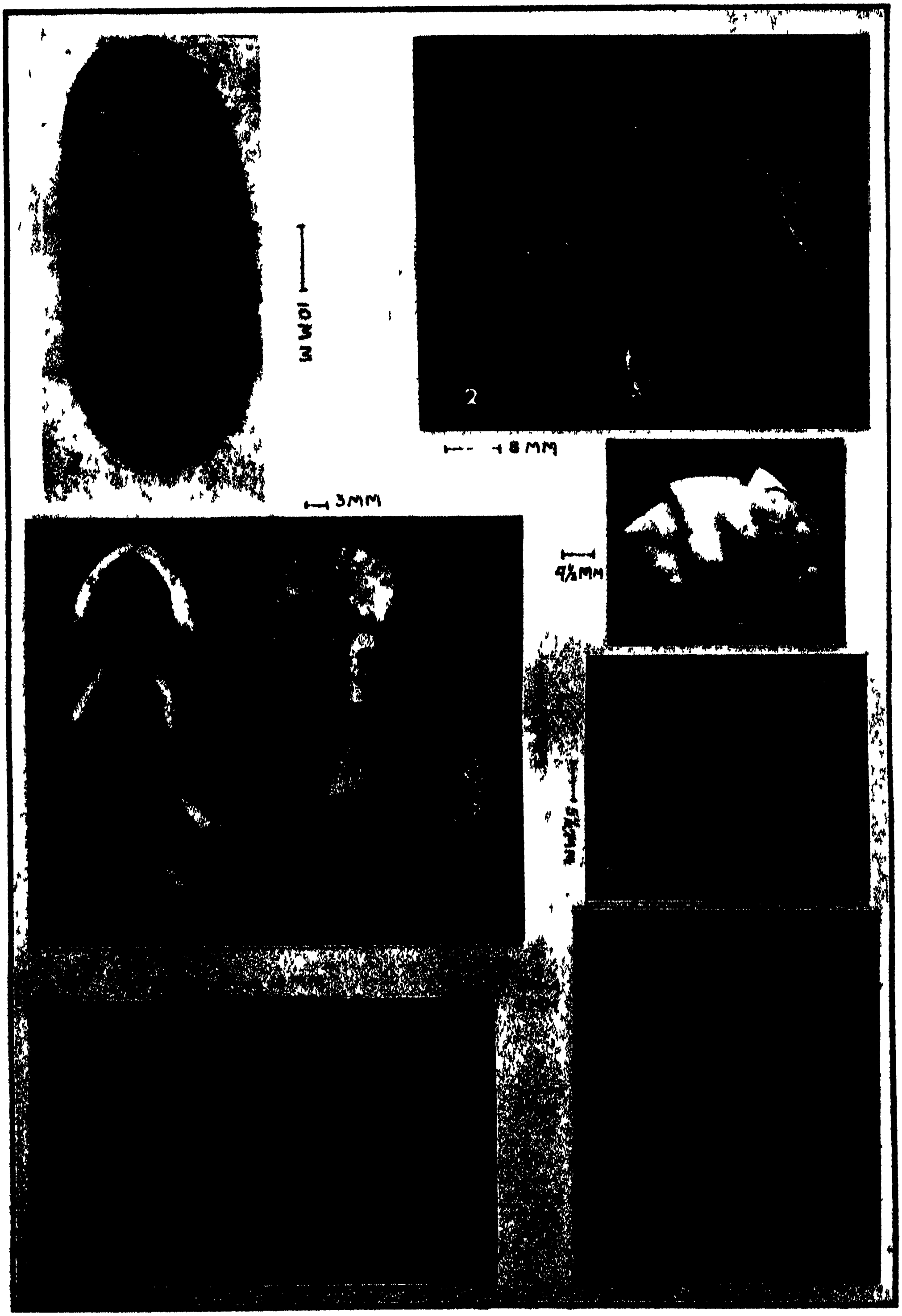

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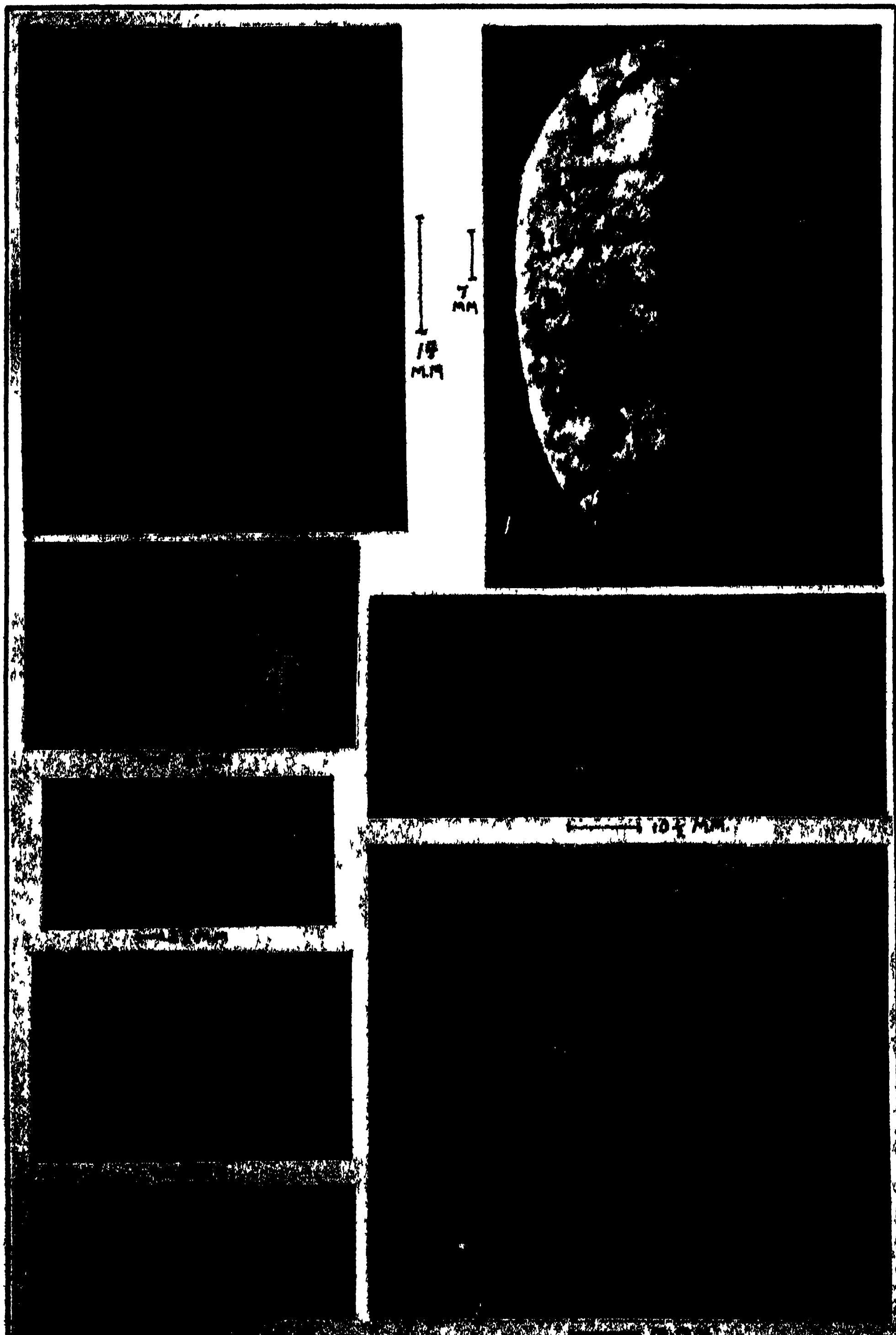

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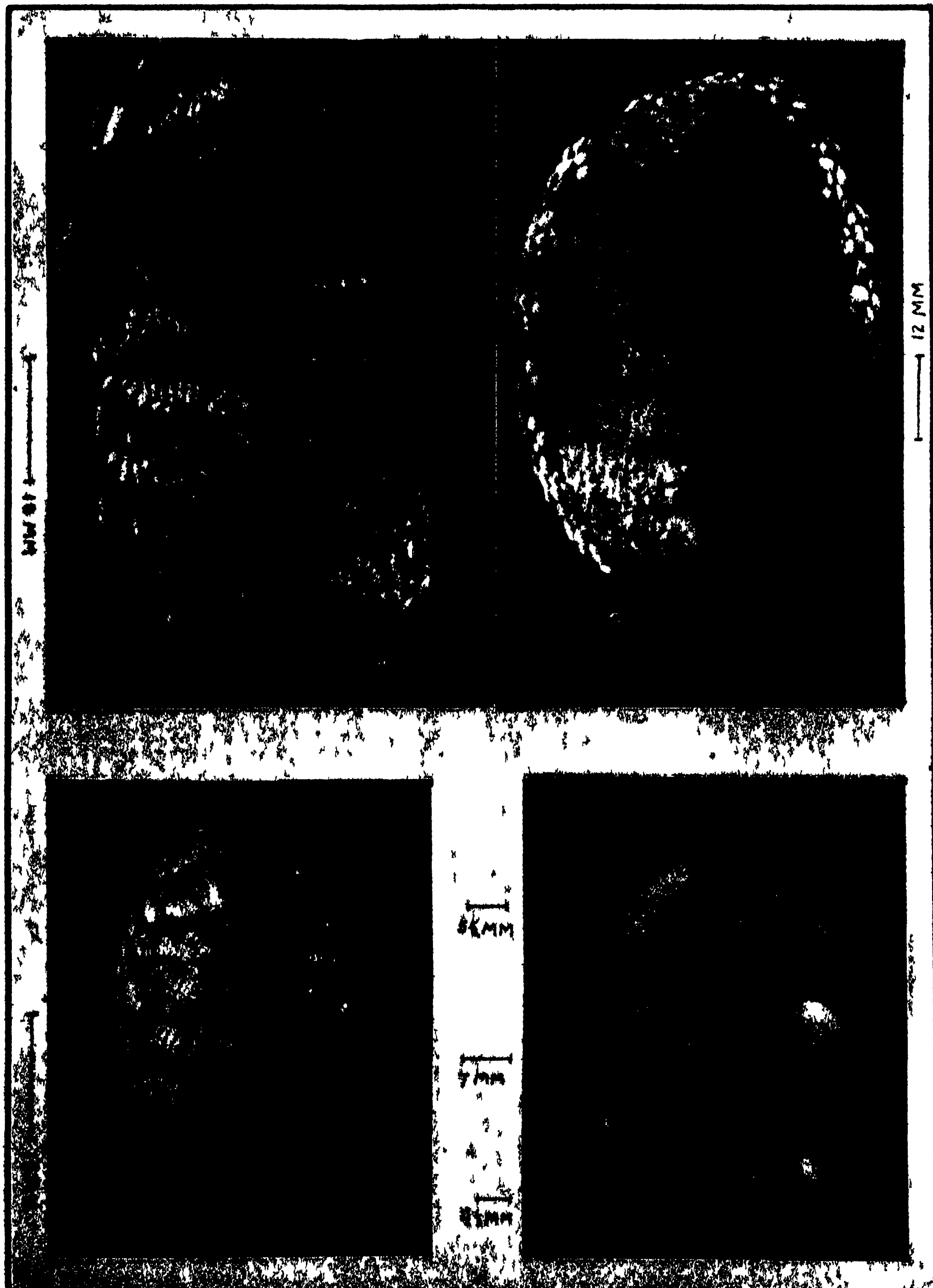

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Fig 1

Fig 2

Fig 3

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Fig 1

Battery of potometers on stand. The plants from left to right are *Atriplex vesicarium*, *Geijera parviflora*, *Casuarina lepidophloia*, *Pholidia scoparia*, *Kochia sedifolia*, *Rhagodia Gaudichaudiana*. The atmometer is shown on the extreme right of the stand and the thermometer on the left.

Fig 2.

Shows the situation in which the work was carried out. The shrubs are chiefly *Kochia sedifolia* and *Acacia* spp., with a little *Atriplex vesicarium*. The trees are *Myoporum platycarpum* and *Casuarina lepidophloia*. Mallee scrub can be seen in the distance.

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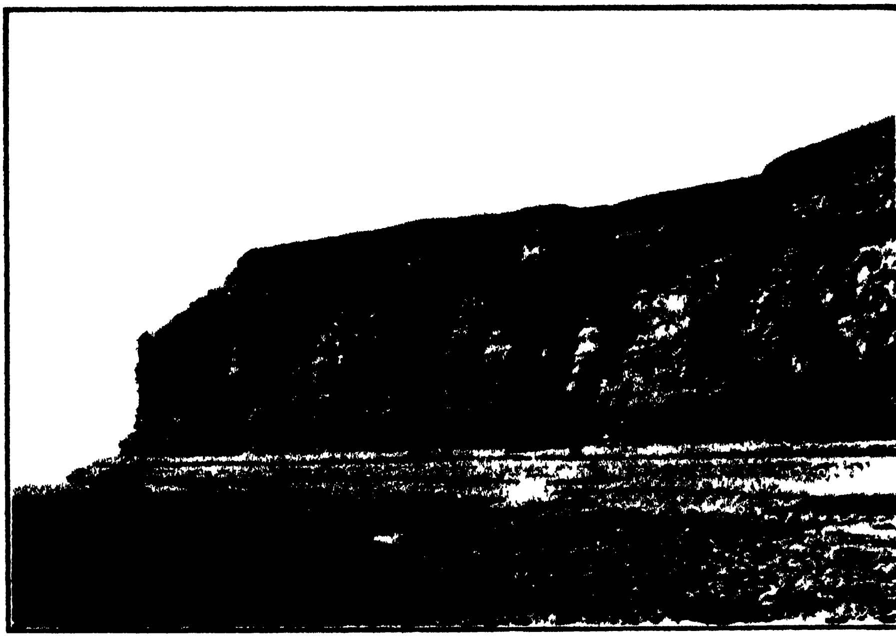

Fig 1 View of the southern face of Blanche Point

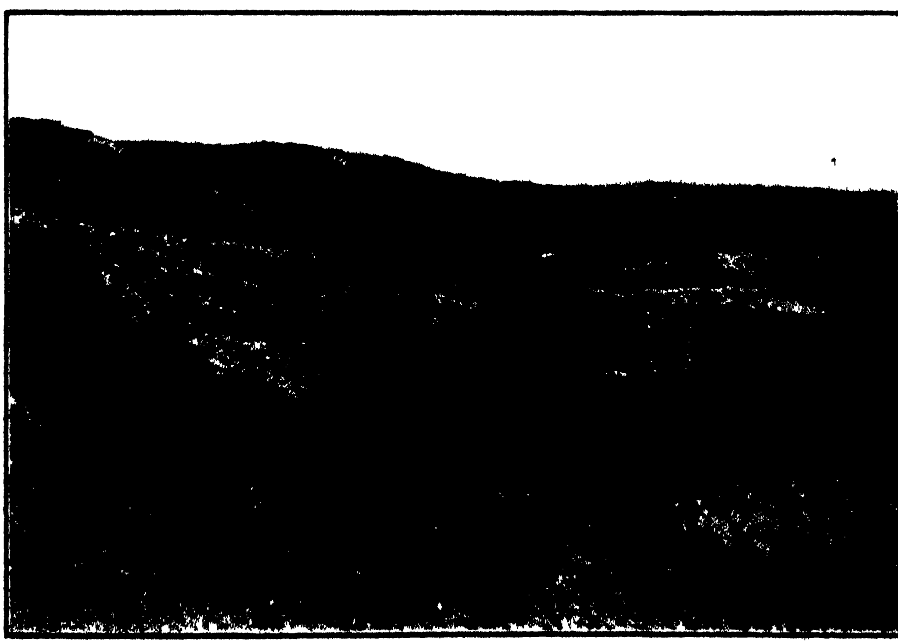

Fig. 2 Pliocene mid-platform showing retreat of upper part of Cliff, Blanche Point

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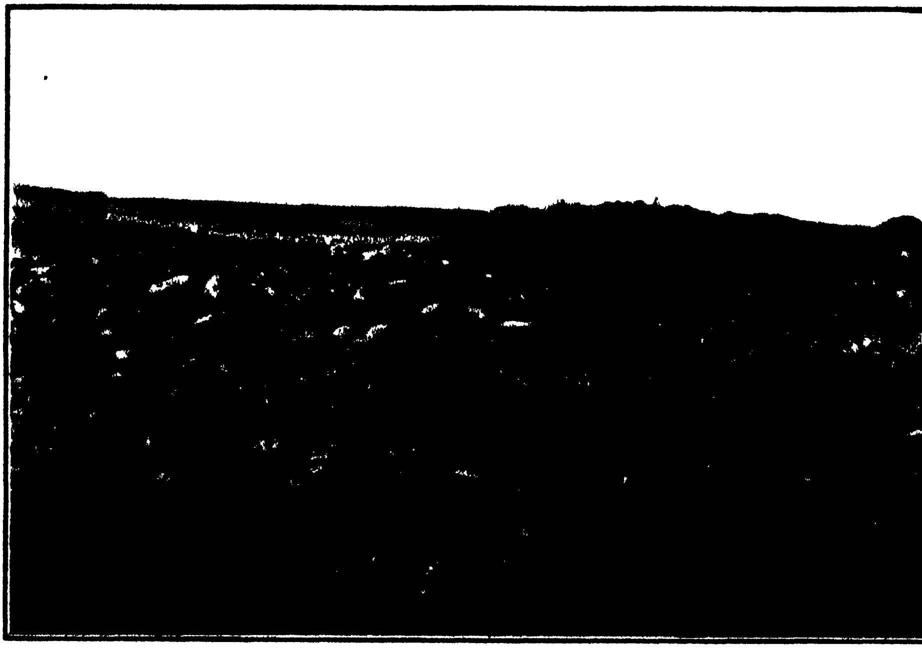

Fig. 1. Raised Beach, in Sandhills, near Pedler's Creek

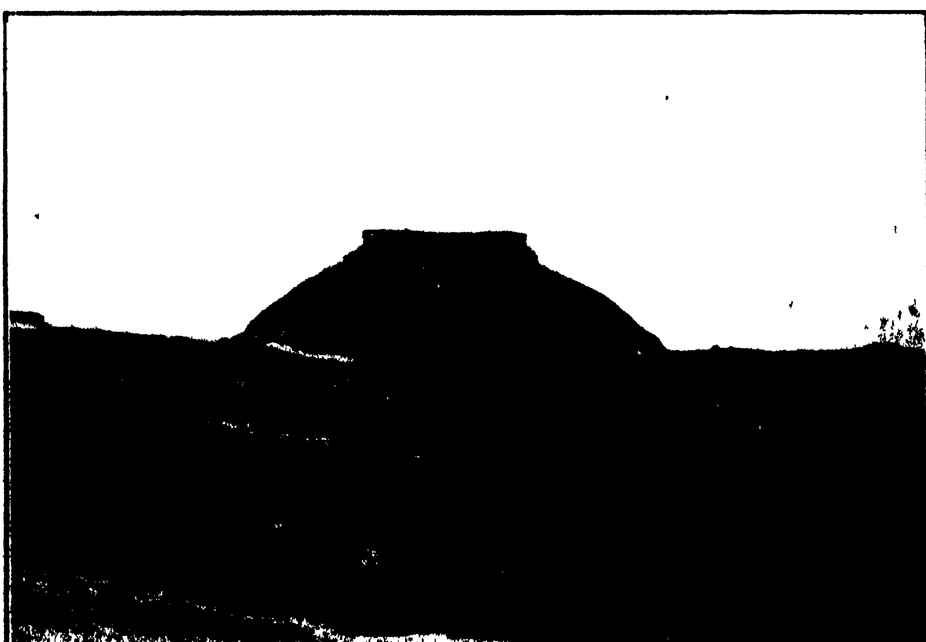

Fig. 2. Butte in Pleistocene Beds, north side of Morphett Vale Creek.

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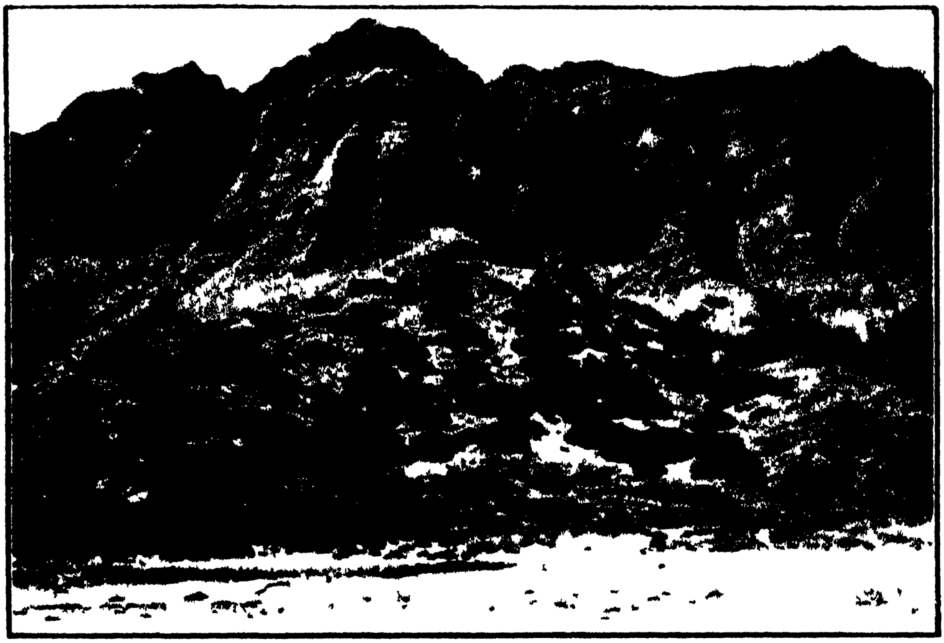

Fig 1 Gravel Beds, 200 feet high, Sellick's Hill beach

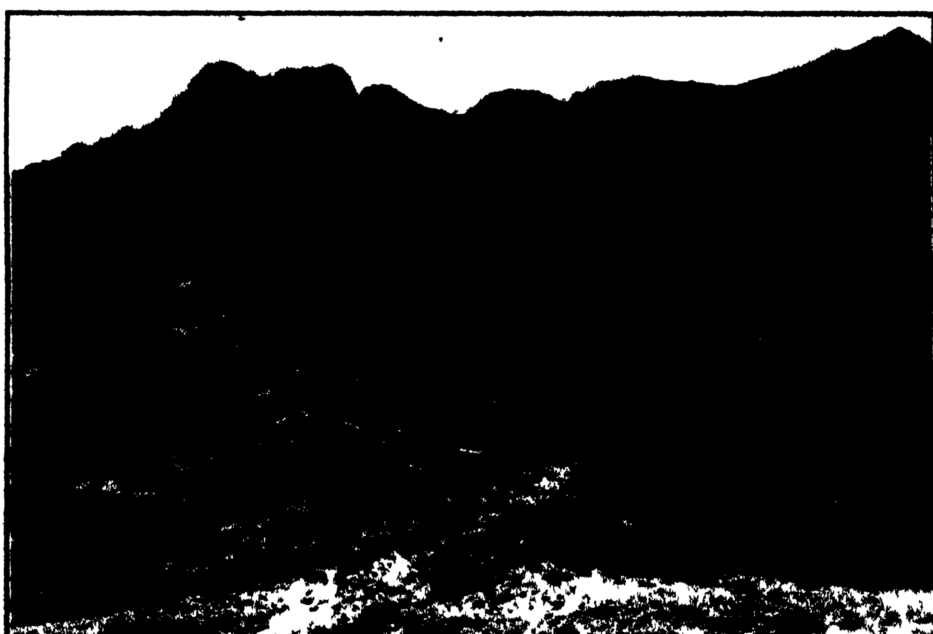

Fig 2. Another view of Gravel Beds at short distance from those seen in Fig. 1.

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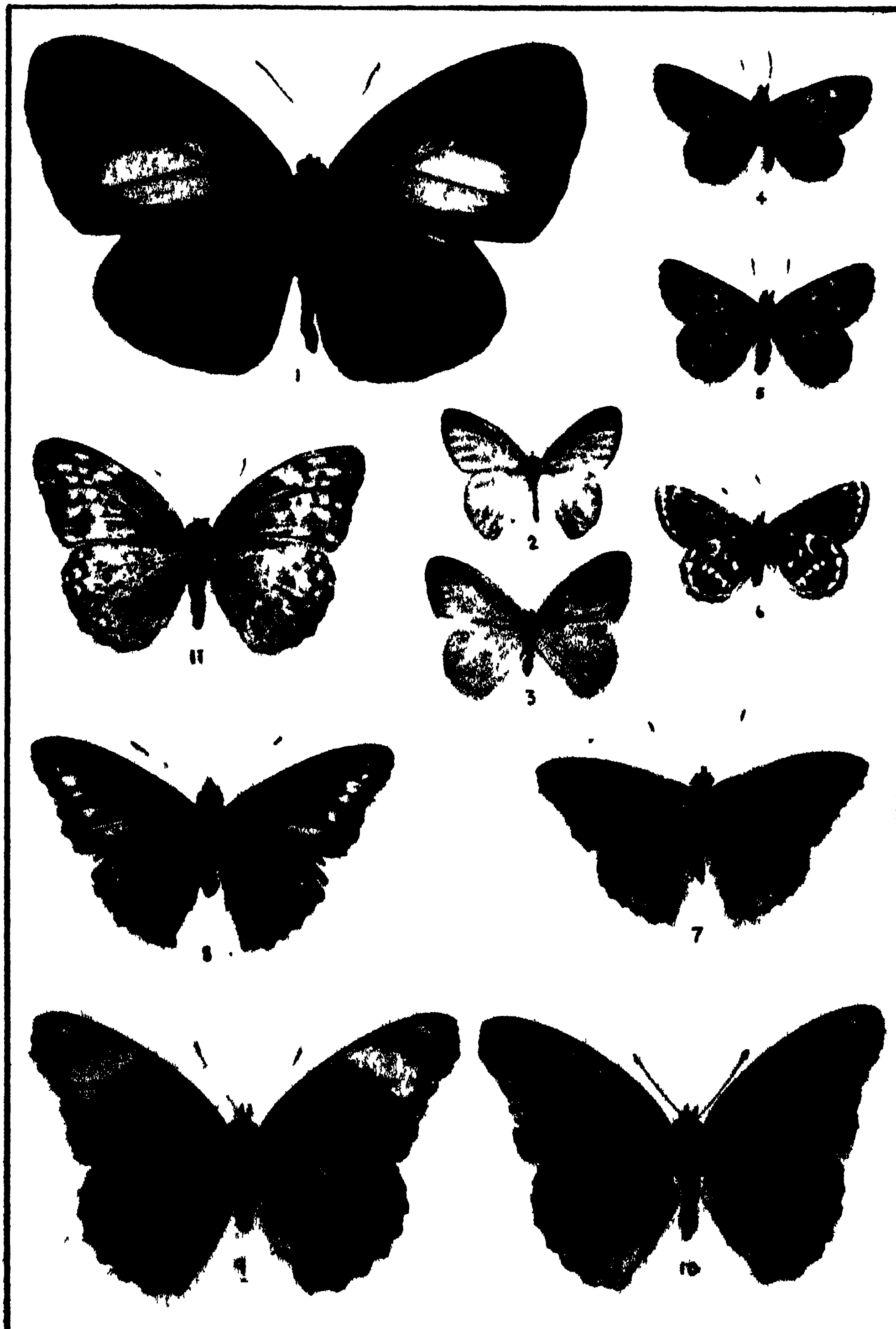
Pterostylis decurva.

Gillingham, Swann



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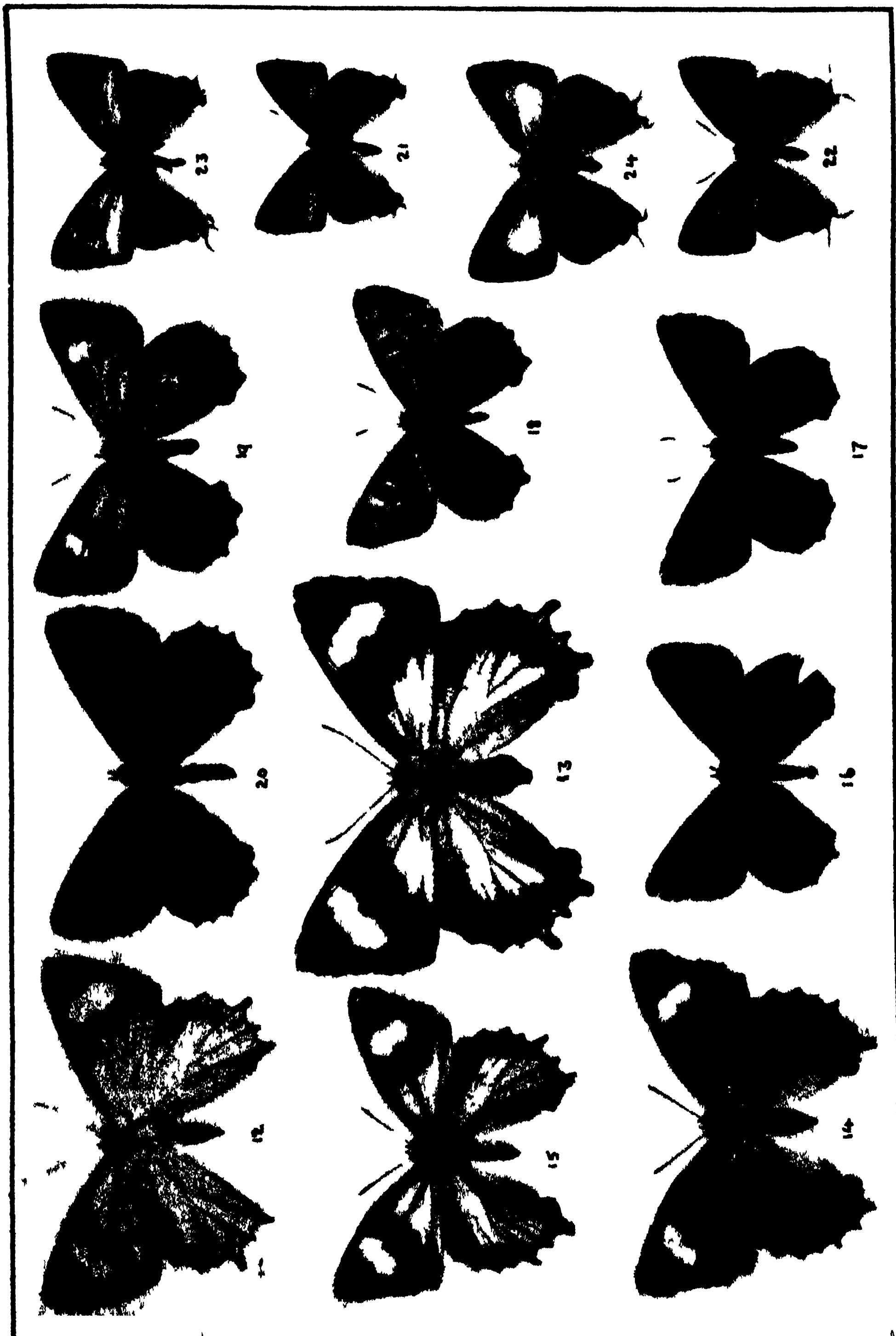

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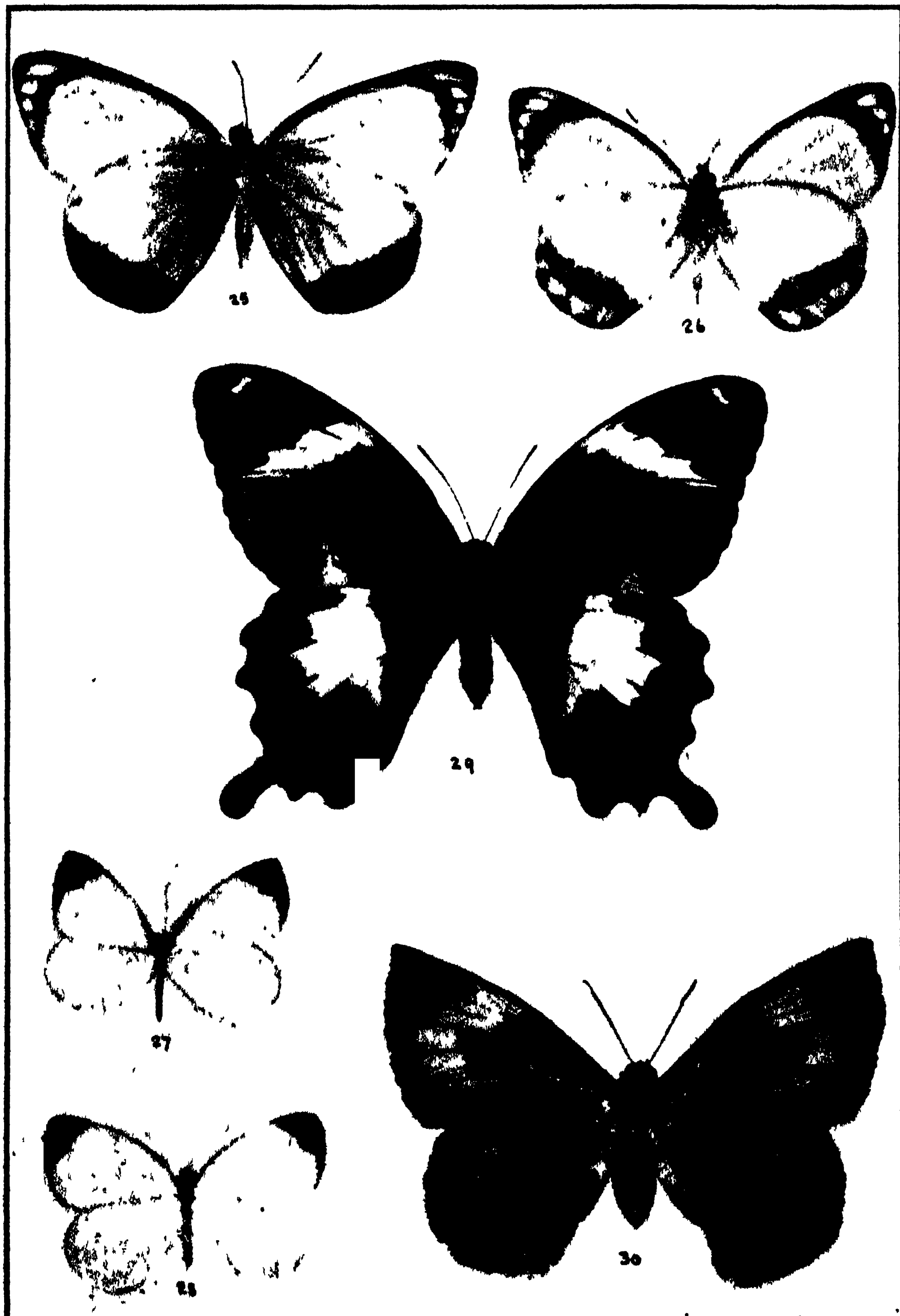

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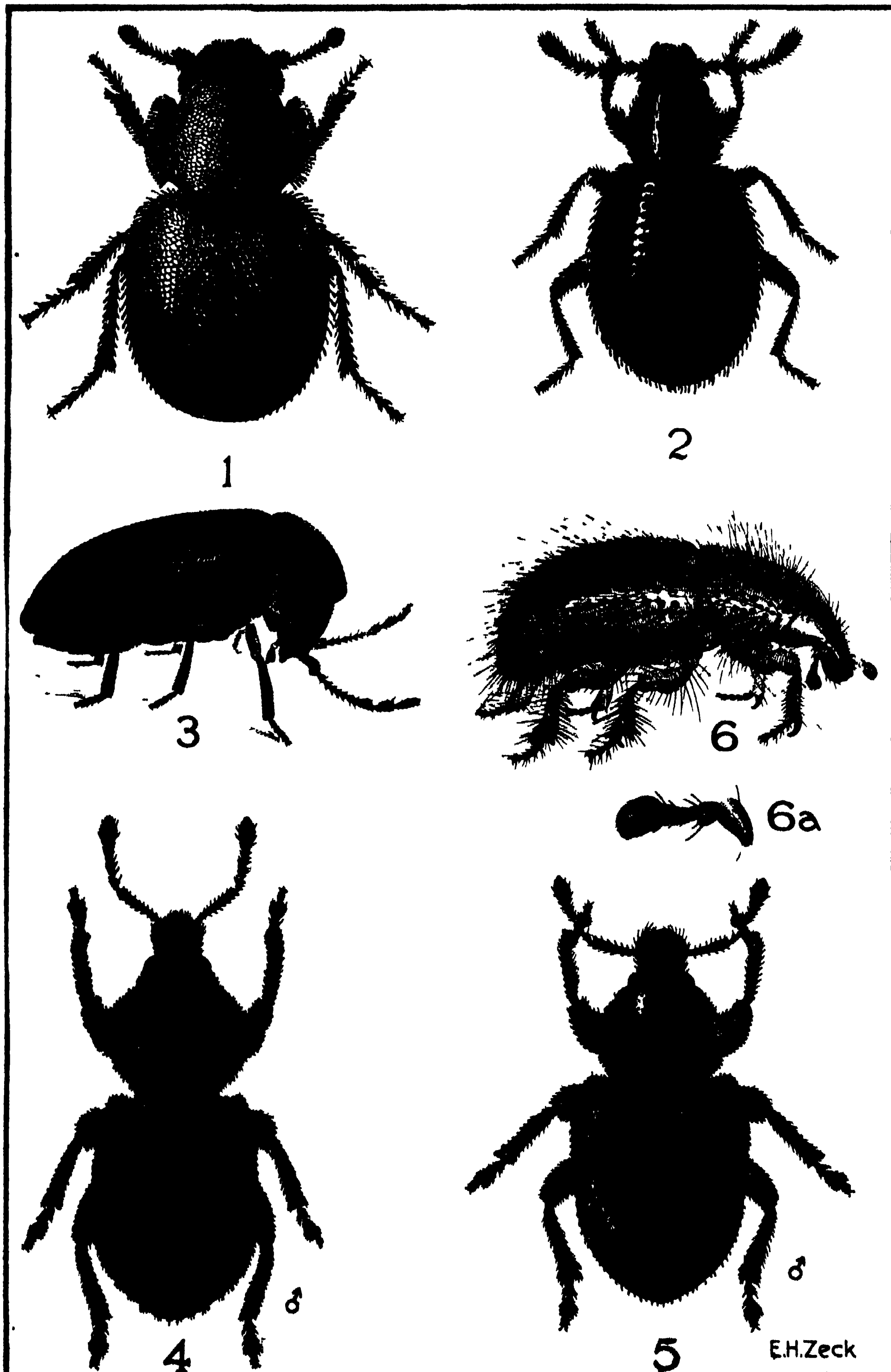

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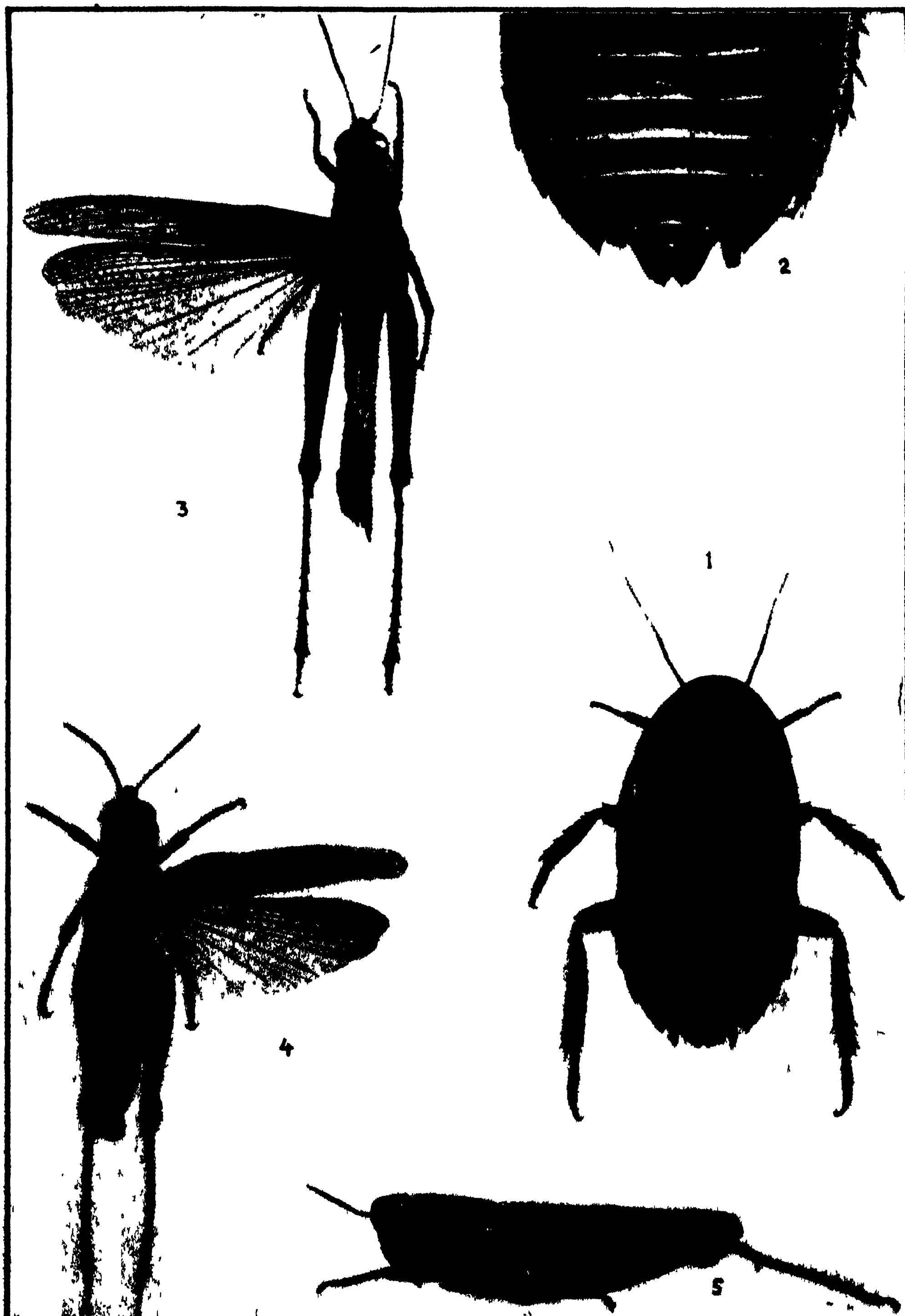

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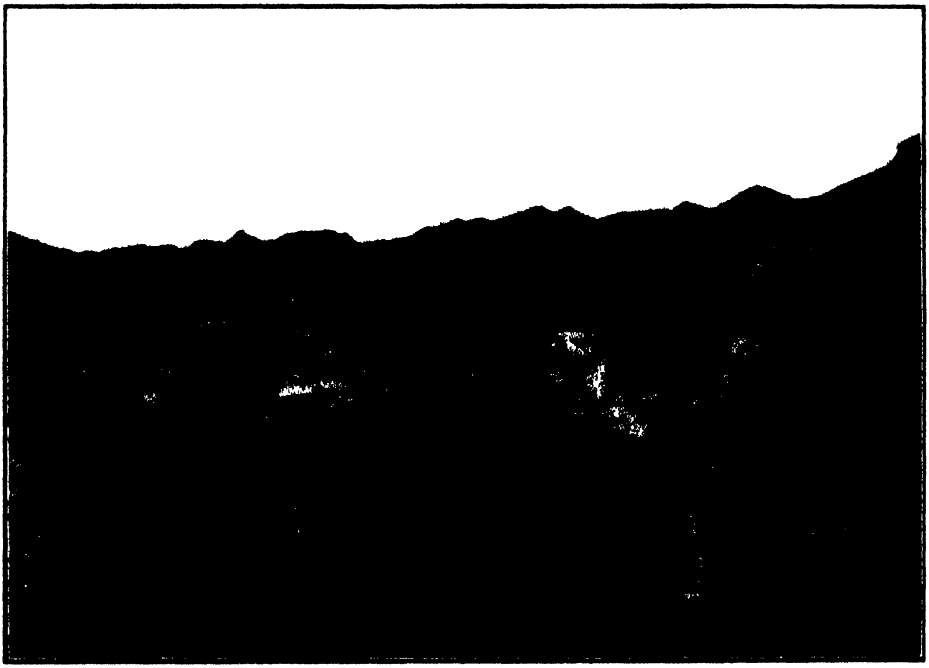

Fig. 1. Entering Yudanamutana.

Fig. 2. The Quartzite of the Yudanamutana Gorge.

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Fig. 1. The Central Belt looking North from Radium Ridge.

Fig. 2. The Imposing Summit of Mount Painter from Radium Ridge.

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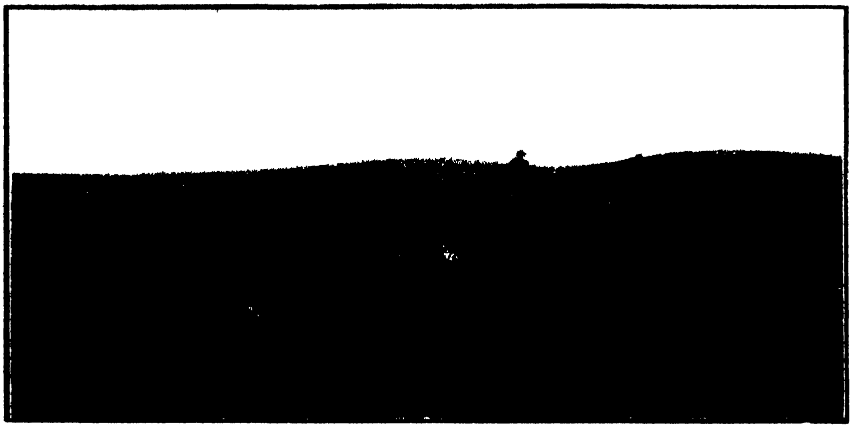

Fig. 1.

Fig. 2

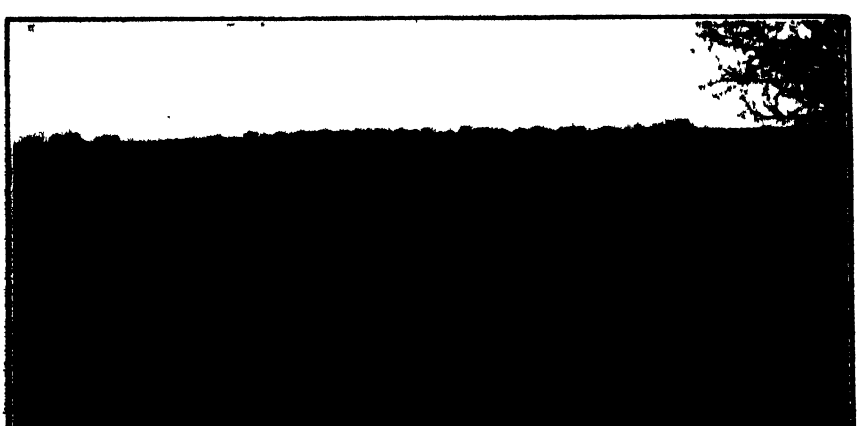

Fig. 3.

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Fig. 1.

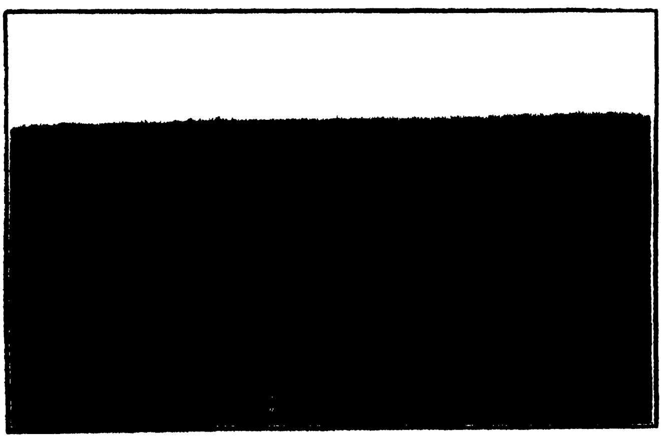

Fig. 2

Fig. 3.

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TRANSACTIONS AND PROCEEDINGS

OF THE

ROYAL SOCIETY OF SOUTH AUSTRALIA

(INCORPORATED)

VOL XLVIII

[WITH PORTRAIT, THIRTY-ONE PLATES, AND SIXTY-SIX FIGURES IN THE TEXT.]

EDITED BY PROFESSOR WALTER HOWCHIN, F.G.S.

ASSISTED BY ALBERT H. ELSTON, F.L.S.

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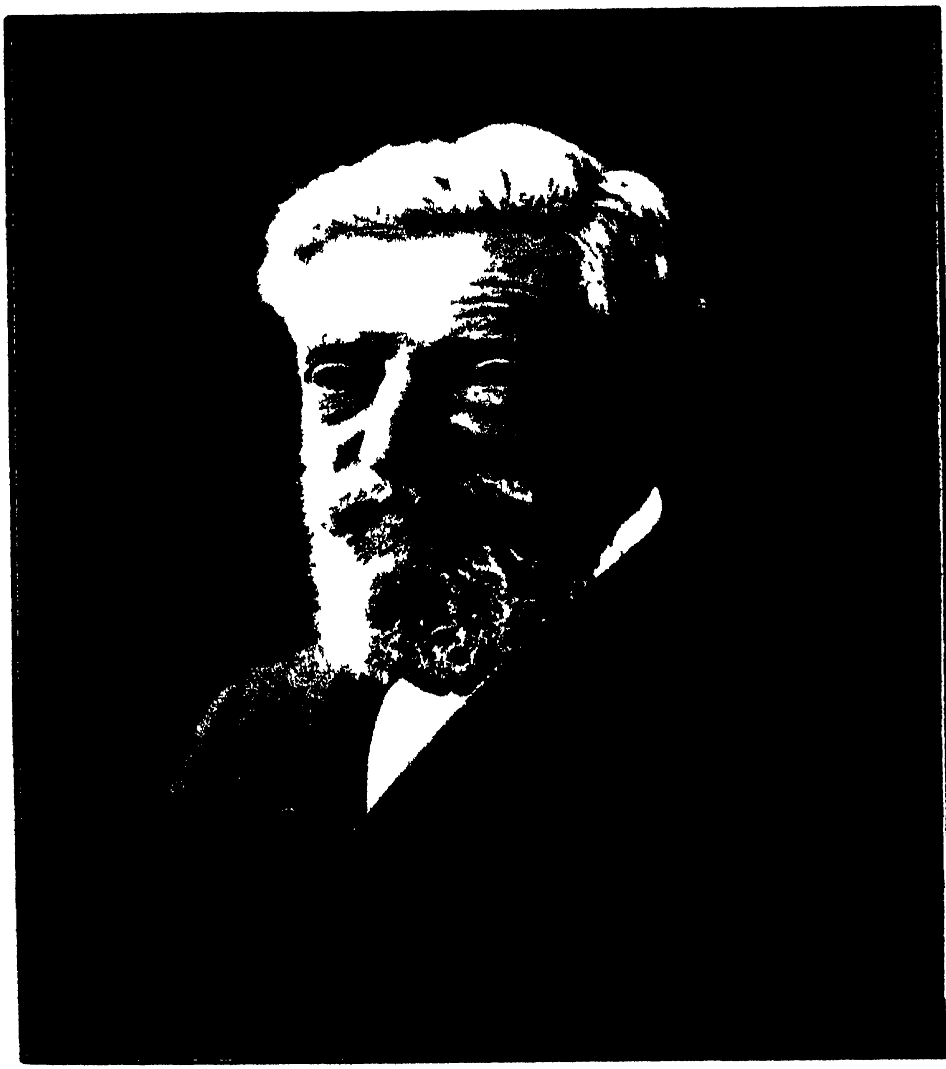
ERRATA—Page 9, Explanation of Plate III For fig 6, Anterior leg of *D personata*, male, read fig 6, Anterior leg of *D zealandiae*, female, and for fig 7, Anterior leg of *D zealandiae*, female, read fig 7, Anterior leg of *D personata*, male



THE LATE WALTER RUTT, C E

Transactions

of

The Royal Society of South Australia (Incorporated)

VOL. XLVIII.

OBITUARY NOTICE (WITH PORTRAIT).

WALTER RUTT, 1842-1924.

With deep regret we have to record the passing of the Senior Fellow of this Society, Walter Rutt, on the 17th May, at his home in College Park.

It is comforting to have the assurance of his friends that he did not suffer, but maintained his usual health and interests practically up to the time of his death.

Only two days previously he visited the Society's rooms, and after performing various duties connected with his office, inserted his photograph in the Society's album. He was well on Saturday morning, but developed what appeared to be a slight cold during the day. This did not, however, cause him to retire before his usual hour at 9.30. At 11 o'clock he was dead.

His death will be regarded as the removal of a familiar landmark, which has witnessed the growth, the expansion and vicissitudes of fortune, of this Society during the last 55 years.

Though his life appears to have been singularly devoid of striking incident and deep contrasts, such as fall to the lot of some men, it was nevertheless a life of good and useful purpose and quiet achievement.

He was born in London, where he was educated at University College School, and subsequently trained as a Civil Engineer. He migrated to this State when he was 27, and immediately entered the Engineer-in-Chief's Department, where he remained until he reached the retiring age twelve years ago. He was in no sense a rover.

In 1869, soon after his arrival, he became a member of the old Adelaide Philosophical Society during the days of its greatest stress and adversity, at a time when it was necessary to realize on its books and movable property in order to meet its financial obligations.

At various times, as Hon. Secretary or Hon. Treasurer, he held office for a cumulative period of forty years, during which he gave the most devoted and meticulous service to the affairs of the Society.

In 1880, as Hon. Secretary, he was one of the signatories to the memorial which petitioned for the Royal permission to change the title of the old Society to that of "The Royal Society of South Australia."

Mr. Rutt never became President, but occupied the Vice-Presidency from 1909-1911.

During his long membership he only contributed two papers to the Transactions, one on "The Flight of Birds considered in connection with Aerostatics," and the other "Notes on a Boring at Port Wakefield."

The photograph in the Society's album, and which appears as the Frontispiece to the present volume, was taken in 1917.

R. S. Rogers.

June 12, 1924.

NOTES ON AUSTRALIAN CRUSTACEA.

No. II.[1]

By Herbert M. Hale.

(Contribution from the South Australian Museum.)

[Read April 10, 1924.]

Plates I. and II.

Family GNATHIIDAE.

Two species of these remarkable Isopods have been hitherto noted from Australian waters, but no member of the suborder has been previously recorded from the southern coast.

The characteristic pseudo-mandibles of the male are doubtless utilized to grasp the female during copulation. In describing a sponge-dwelling species from South Africa, Barnard writes: "The male was found either sitting in the mouth of the burrow with the mandibles just projecting or clasping the female."[2]

In each of the species listed below, the male is known from only one specimen. Undoubtedly a great number of small forms of Crustacea inhabiting the waters of South Australia remain to be collected.

Gnathia, Leach.

Gnathia, Leach, Edinb. Encycl., vii., 1814, p. 402; Barnard, Ann. South Afr. Mus., x, 1914, p. 201, and xvii., 1920, p. 332 (syn).

Anceus, Hesse, Comptes rendus, 1855, and Ann. Sci. Nat. (4), ix., p. 93.

Ancaeus, Hesse, Ann. Sci. Nat. (5), xix., 1874, p. 8.

Key to Males of Australian Species.

a. Medial length of head three-fourths, or more than three-fourths, the greatest width. Third and fourth thoracic segments separated by a marked constriction.

b. Dorsum of head almost covered with small, rounded, uniform tubercles; not areolate; not deeply excavate anteriorly. Fifth and sixth thoracic segments medianly divided dorsally. Length, 2·5 mm. .. .. *latidens*

bb. Dorsum of head with large and small tubercles on anterior third only; remainder with large and distinct areoles; deeply and broadly excavate anteriorly. Fifth and sixth thoracic segments not split. Length, 4·1 mm. .. .. *mulieraria*

aa Medial length of head less than three-fourths the greatest width. Third and fourth thoracic segments not separated by a constriction.

c. Anterior margin of head deeply incised, with a median tooth which does not reach to the level of the antero-lateral angles of head. Eyes small. Mandibles large, longer than head. Fifth and sixth thoracic segments not split dorsally .. .. *ferox*

cc. Anterior margin of head produced, the middle reaching beyond level of antero-lateral angles of head. Eyes moderately large. Mandibles small, about one-half length of head. Fifth and sixth thoracic segments medianly divided dorsally .. .. *pustulosa*

The characters given for *G. ferox* are taken from Haswell's description and figure.

[1] No. I. appeared in Rec. S. Austr. Mus., 1924.

[2] Barnard, Ann. South Afr. Mus., xvii., 1920, p. 334.

GNATHIA FEROX, Haswell.

Anceus ferox, Hasw., Proc. Linn. Soc. N.S. Wales, ix., 1885, p. 1005, pl. lii., figs. 1-5.

Hab.—New South Wales: Port Jackson.

GNATHIA LATIDENS, Beddard.

Anceus latidens, Beddard, Proc. Zool. Soc., 1886, p. 120, and Rep. Sci. Res "Challenger" (Zool.), xvii., 1886, p. 141, pl. xviii., fig. 11.

Hab.—Northern Australia, Flinders Passage, 7 fms.

Gnathia mulieraria, n. sp.

Pl. i., figs. 1-8; pl. ii., figs. 1-3.

♂. *Head* large, subquadrate in outline, the medial length more than three-fourths the width; dorsum anteriorly forwardly inclined and broadly excavated, the depression deepest and widest in front; at base of head is a small furrow on each side of the median line; at the bottom of the large excavation is a large, elongate-oval tubercle, almost one-third the length of the head and arising near the anterior margin of the head; on each side of the central tubercle is a large, obtusely-conical tubercle, behind which, and nearer the eye, is another similar but smaller projection; to the rear of the latter is an oblique row of three tiny tubercles; posterior three-fourths of dorsal surface with eight large areoles; on the interspace alongside the outermost of these is a longitudinal row of tiny spinules; anterior margin of head sinuate, prominently tridentately produced between mandibles; antero-lateral angles crowned with a forwardly-directed, unevenly-quadrate tubercle, which overhangs the base of the antennae. Eyes small, their longitudinal diameter one-fourth the length of the head. Antennae long, the first pair extending to the second-third of the fourth joint of the second pair. First joint of superior antennal peduncle longer than second joint; third much longer, two and one half times as long as second; flagellum five-jointed, second and third joints longest, subequal in length. Third joint of peduncle of inferior antennae as long as first and second together; fourth nearly half as long again as third; flagellum seven-jointed. Mandibles large and prominent, a little shorter than head, scoop-shaped on inner surface; intero-inferior edge crenulate and superior edge incrassate, notched at the first fourth of the length; distal portion bent upwards and inwards.

Thorax.—Second to sixth segments with more or less distinct small areoles. First short, almost as wide as head, strongly constricted on each side; closely coalesced with head, the suture rather indistinct. Second medianly as long as first, the antero-lateral portions curved forwards, but not quite reaching head; lateral edges twice as long as medial length; posterior margin slightly sinuate. Third as long as first and second together. Fourth separated from third by a marked constriction; nearly one-third longer than third; tumid on each side, the swellings almost meeting medianly. Fifth slightly longer medianly than fourth; lateral margins longer owing to concave posterior margin; slightly swollen towards sides. Sixth twice as long as third, the lateral portions swollen, produced backwards postero-laterally; sides sinuate. Segments one, two, three, and five are subequal in width; segments four and six are narrower; segment seven small and inconspicuous, little more than one-third the width of the sixth and not as wide as the abdomen.

Abdomen moderately large, more than one-fourth of the total length exclusive of the mandibles. Epimera prominent. Sixth (telsonic) segment as long as wide, the margins sinuate; posterior portion with a strong hair on each side; apex subacute with two setae. Uropoda elongate, subtruncate

apically; inner branch (not counting marginal setae) extending to level of termination of abdomen, as long as, but wider than outer branch; terminal setae as long as uropods and their peduncle together.

Peraeopods.—First pair operculiform, two-jointed; basal joint large with three distinct areoles; fringe of hairs on inner edge rather stout, spaced; second joint one-fifth as long as first, subcircular, with several setae at apex. Second to sixth pairs moderately strong, armed with a few spines and some long hairs.

Pleopods short, with long apical setae; about one-fifth as long as abdomen.

Colour (during life).—Antennae, legs, mandibles, and tubercles of head white. Aeroles of dorsum of head and thorax yellow; interspaces pale brown, closely dotted with brown chromatophores, which become larger and more diffused on the posterior two-thirds of thorax. First to fifth abdominal segments pale yellow, with a few chromatophores at sides; telsonic segment, uropods and pleopods subhyaline.

Length (excluding mandibles), 4·1 mm.; width of head, 1·1 mm.; greatest width of thorax, 1·05 mm.; length of abdomen, 1·05 mm.

PRANIZA LARVA.—*Head* small, subtriangular, with the mouth parts projecting. Eyes large, occupying nearly the whole of the lateral margin. First antennae as long as peduncle of second pair. Flagellum of superior antennae four-jointed, the second joint much the longest. Fourth joint of peduncle of inferior pair twice as long as third joint; flagellum seven-jointed.

Thorax.—First segment short, narrow, inconspicuous. Second wider than head, a little curved forwards. Third longer and wider than second. Fourth, fifth, and sixth more or less swollen, the posterior sutures of fourth and fifth indiscernible. Seventh small, narrower than abdomen.

Abdomen.—Much as in adult male.

Peraeopods.—The six pairs of subprehensile legs are relatively much more slender than in the male.

Colour.—Head pale testaceous, with a few crowded black spots. Thorax milk-white, with a few scattered, hieroglyphic-like black chromatophores. First to fifth segments of abdomen white with sparse black chromatophores; telsonic segment, uropods and pleopods subhyaline.

Length, 3·1 mm. to 3·7 mm.; greatest width of thorax, ·91 mm. to 1·35 mm.

Hab.—South Australia: Gulf St. Vincent, 7-8 fms. (H. M. Hale). Type, South Australian Museum (Reg. No., C. 198).

A single male, and several Praniza larvae, presumably belonging to the same species, were taken from amongst masses of *Zostera* brought up in the dredge, during a recent excursion of the Field Naturalists' Section of the Royal Society.

The large mandibles, distinctive tubercles, and large excavation of the fore part of the dorsum of the head, are salient characters for this species.

Gnathia pustulosa, n. sp.

Pl. ii., figs. 4-7.

♂. *Head* large, transverse, about one and two-thirds times as wide as medianly long; almost wholly covered with small granules and not divided into areoles; anterior margin a little produced forwards and medianly slightly bilobed; antero-lateral margins incrassate; a longitudinal, mesial furrow on dorsum for about three-fourths of the length, deepest anteriorly, and a shallow fovea on each side of posterior portion of head; hinder margin concave. Eyes

small, their longitudinal diameter about four and one-half times in the width of the head. Superior antennae short and stout; second joint of peduncle a little shorter than first, the third one and two-thirds times as long as second; flagellum five-jointed, the first joint short and the second about as long as the third and fourth together. Inferior antennae damaged; fourth peduncular joint equal in length to second and third together. Mandibles moderately large, not very conspicuous when folded; scoop-shaped on inner surface; less than half as long as the head; superior margin notched towards middle of length.

Thorax.—None of the segments is separated by a constriction. First segment small and narrow, half the width of the head, with the suture distinct; surface granulate. Second distinctly wider than head, expanded on sides, the lateral edges being about twice as long as the medial length; greater part of surface granulate; posterior margin convexly sinuate, medianly a little incised; antero-lateral margins in contact with head. Third wider than any other segment; expanded on sides, the lateral edges more than twice the medial length, which is scarcely greater than that of the first segment; posterior margin concavely sinuate, medianly incised, with edges of incision incrassate; granulate on part of surface. Fourth a little longer medianly than first three together, laterally considerably shorter; anteriorly with a median, submarginal tooth, which fits beneath the incrassate incision of the preceding segment; posterior margin almost straight. Fifth split medianly, each of the halves with a nick at the middle of the length of the inner edge; posterior margin straight. Sixth split medianly; narrowed posteriorly and with lateral portions slightly swollen. Seventh one-fourth as wide as sixth, subrectangular, narrower than abdomen.

Abdomen small, curved beneath the body.

Peraeopods.—First pair operculiform, with the basal joint large, without apparent areolation and with a fringe of short, fine hairs on inner edge; second joint rudimentary. Second to sixth pairs stout, armed with a few blunt spines, tubercles, and hairs.

Pleopods one-half as long as the abdomen, without setae.

Colour (in spirit).—Dirty yellow with granulae and mandibles white. Eyes black.

Length (excluding mandibles), 3·15 mm.; width of head, 1·01 mm.; greatest width of thorax, 1·18 mm.

♀ (distended with ova). *Head* rounded in front, very slightly concave medianly. Eyes about half as long as head.

Peraeopods much more slender than in male.

Thorax.—All of the sutures are discernible, those of the swollen portion (fourth to sixth) rather indistinct. Ova subreniform.

Colour.—White with eggs yellow.

Length, 3·2 mm.; greatest width of thorax, 1·55 mm. Ova: length, ·29 mm. to ·35 mm.; width, ·19 mm. to ·24 mm.

Hab.—South Australia: Glenelg (W. H. Baker). Type, South Australian Museum (Reg. No., C. 199).

A single pair, somewhat mutilated. Some years ago Mr. Baker found these clinging to a sponge washed up near the mouth of the Patawalonga Creek after heavy weather. In both sexes the abdomen is small and curved beneath the thorax; owing to the poor condition of the specimens it is not possible to accurately figure the telson, etc.

Besides the characters given in the introductory key, this species differs from the other three Australian species as follows:—The anterior margin of

the head is not tridentate, as in *G. latidens* and *G. mulieraria*, or excavated, as in *G. ferox*. As in *G. latidens*, the head is almost uniformly tuberculate dorsally, and the fifth and sixth thoracic segments are medianly split; the granules, however, are smaller, the third and fourth thoracic segments are not separated by a constriction, and the mandibles are much smaller than in that species. The dorsum of the head has a median anterior furrow and two posterior foveae, whereas *G. latidens* has only a posterior median groove.

EXPLANATION OF PLATES I. AND II.

Plate I.

Fig. 1. *Gnathia mulieraria*, male; enlarged 25 diams.
„ 2-4. Dorso-interior, ventral and lateral views of right pseudo-mandible; enlarged 50 diams.
„ 5. Superior and inferior antennae; enlarged 125 diams.
„ 6. First peraeopod; enlarged 50 diams.
„ 7. Second peraeopod; enlarged 50 diams.
„ 8. Terminal segments of abdomen and uropods; enlarged 100 diams.

Plate II.

Fig. 1. Praniza larva of *Gnathia mulieraria;* enlarged 28·5 diams.
„ 2. Superior and inferior antennae; enlarged 143 diams.
„ 3. Tip of maxilla; enlarged 336 diams.
„ 4. *Gnathia pustulosa*, male; enlarged 28·5 diams.
„ 5. Dorso-interior view of left mandible; enlarged 143 diams.
„ 6. Superior antenna; enlarged 143 diams.
„ 7. First peraeopod; enlarged 57 diams.

STUDIES IN AUSTRALIAN AQUATIC HEMIPTERA. No. IV.[1]

By Herbert M. Hale.

[Read April 10, 1924.]

The Corixid Genus Diaprepocoris.

Plate III.

In 1897 Kirkaldy described a Corixid from south-eastern Australia which differed so considerably from any other known species that he erected for its reception the monotypic genus *Diaprepocoris*. Kirkaldy's specimens of the type species are cited as being females, but in 1922 the writer pointed out that superficially the male can be distinguished only when the wings are extended. The abdominal segments in this sex are not strikingly disordered as in other members of the genera of Corixidae; the fifth and sixth dorsal segments are, however, split, and these and the terminal segment are comparatively slightly asymetrical, the irregularity being scarcely discernible on the venter. Also, the male has another sexual character, a curious apparatus, which the writer has supposed to be stridulatory, on the fifth and sixth dorsal abdominal segments.

In his original description Kirkaldy remarks: "Palae bisegmentate. . . . This second segment appears to be a genuine second tarsal segment, not a single claw." The palae of the type species are thin, sublunate, and the inner face is not as deeply spooned, or as widened, as in the majority of the Corixids.

There are now available two other species, which, while undoubtedly congeneric with *D. barycephala*, differ quite considerably in the form of the palae, which approach in shape those of the *Corixa* group; the pronotum in both of the new forms is even more transverse than in the type species.

Prof. Hungerford has proved that, without doubt, most of the water boatmen are largely herbaceous feeders, and that the remarkably modified anterior tarsi (or palae) are excellently formed for the scooping up of decayed vegetable matter, infusoria, etc., from the bottom of ponds. In aquaria Hungerford recommends feeding these bugs with finely-minced water weed, which in a short time encourages the propagation of astonishing quantities of infusoria. The writer has successfully maintained Corixids thus, and it may also be noted that some of our larger forms, such as *Porocorixa eurynome*, readily feed upon mosquito larvae when supplied to them.

One American species of the family, *Cymathia americana*, Hussey, is known to be carnivorous; the palae of *D. barycephala* are structurally somewhat similar to that species. The palae of the other two species described below indicate that their feeding habit is more in accordance with that of most other Corixids. The so-called second tarsal joint of *D. barycephala* seems to be a well-developed palal claw; in *Cymathia americana* the claw is quite as strong.

Ocelli are said to be absent in the Corixidae, but in the three species of *Diaprepocoris* there is a tiny, circular, very slightly convex, blackish area on the notocephalon near the inner margin of each eye; this appears to be a small ocellus, and should be regarded as of generic importance.

(1) Nos. I.-III. appeared in Rec. S. Austr. Mus., 1922-1924.

Diaprepocoris, Kirkaldy.

Diaprepocoris, Kirkaldy, Ann. Mag. Nat. Hist. (6), xx., 1897, p. 52; Hale, Rec. S. Austr. Mus., i., 1922, p. 328.

Type, *D. barycephala*, Kirkaldy.

This genus may be separated from its allies by the following combination of characters. Notocephalon shining; two ocelli present. Pronotum very short and finely rugose, without transverse lines of colour. Scutellum large, at least three-fourths as wide as the prothorax, dull, clothed with tiny hairs. Hemelytra more or less dull, without small vermiculate or angulate markings; clavus and corium clothed with fine hairs. Palae similar in both sexes, with the terminal claw stout. Face convex in both sexes. Last three visible dorsal segments of abdomen of male asymmetric and split; without strigil, but with a stridulating apparatus, composed of two articles, lying on the fifth dorsal segment, a little to the right of the mid-line of the body.

Distribution (as at present known): Southern and Eastern Australia, Tasmania, and New Zealand.

Key to the Species.

a. Notocephalon about as long as, or slightly longer than, its width at base between eyes, distinctly conically produced in front of eyes. Length, 6 mm. to 8 mm.

  b. Pronotum four to six times wider than medial length. Palae in dorso-lateral view sublunate; interior concave face narrow, with the longest of the hairs fringing the lower margin not longer than greatest width of pala .. .. *D. barycephala*

  bb. Pronotum nine times wider than medial length. Palae in dorso-lateral view falcate; interior concave surface wider, with the longest of the hairs fringing the lower margin much longer than greatest width of pala .. .. *D. zealandiae*

aa. Notocephalon wider posteriorly than medianly long, rounded in front and not much produced in front of eyes. Length, 5 mm. .. .. *D. personata*

Diaprepocoris barycephala, Kirkaldy.

Pl. iii., figs. 1 and 5.

Diaprepocoris barycephala, Kirkaldy, *loc. cit.*, p. 53; Hale, *loc. cit.*, p. 329, fig. 350.

Hab.—South Australia, Victoria, New South Wales, and Tasmania.

Diaprepocoris personata, n. sp.

Pl. iii., figs. 2, 4, and 7.

♂. Notocephalon ochraceous, basally suffused with darker colour; rounded in front and a little produced in front of eyes; medial length less than width between intero-posterior angles of eyes; a very obsolete median carina towards base of head. The slightly raised exposed area of pronotum black, reaching to lateral edges of thorax, almost ten times as wide as medial length; very finely rugose, slightly shining; lateral angles acute; anterior margin shallowly, concavely incised in the middle; posterior margin a trifle sinuate. Scutellum brownish-black, finely punctate and clothed with tiny pale hairs; wider than long and three-fourths as wide as prothorax. Hemelytra subopaque; clavus and corium olivaceous-yellow, slightly glossy, moderately densely clothed with black hairs; inner edge of clavus black; membrane sordid yellow, infuscated with blackish on exterior edge, dull, and with an indication of a branching nervure; embolium brownish-black on inner half, narrowly bordered with ochraceous on external edge. When folded the hemelytra appear black owing to the dark colour of dorsum of abdomen. Legs ochraceous, the intermediate tarsi apically blackish; swimming hairs of posterior legs dark brown. Palae falcate in dorso-lateral view; fringing hairs of interior scoop brownish; anterior tibiae with a

few small spines, closely embracing base of palae; anterior femora with three or four short and stout spines on dorsal side near apex; and with inner face (against which the tibiae fits when the leg is flexed) flattened and somewhat excavate. Intermediate claws subequal in length to tarsi.

Length, 5 mm.; width of prothorax, 1·9 mm.

♀. Length, 5 mm.; width of prothorax, 2 mm.

Hab.—Western Australia: Swan River (type loc.) and Mundaring (J. Clark).

The short head, very transverse pronotum, and falcate palae are the salient features of this species when compared with *D. barycephala*. The stridulatory apparatus on the abdomen of the male is exactly as in the last-named species.

Only two examples were collected; the type was taken by Mr Clark from the nest of an ant *(Iridomyrmex conifer)* which he was engaged in working for inquiline Coleoptera.

Diaprepocoris zealandiae, n. sp.

Pl. iii., figs. 3 and 6.

♀. Notocephalon testaceous, conically produced in front of eyes, its width at base between eyes about equal to the medial length; with a very obsolete carina towards base of head; posterior margin of head almost evenly concave. The slightly raised area of pronotum ochraceous, not reaching to lateral edges of thorax and nine times as wide as medial length, rugose, the rugae subnitid; lateral angles subacute; anterior margin shallowly concavely incised medianly and posterior margin very slightly sinuate. Scutellum testaceous, finely rugose, and clothed with very short, sparse pubescence; wider than long and three-fourths as wide as the prothorax. Hemelytra sordid yellow; clavus and corium clothed with fine golden hairs, longer than those of scutellum; embolium ochraceous, a little infuscated on inner half. Legs testaceous. Palae falcate in dorso-lateral view; anterior tibiae closely embracing base of palae. Intermediate legs rather stout.

Length, 6·1 mm. wide; width of prothorax, 2·1 mm.

Hab.—New Zealand (Pascoe Coll., in British Museum).

A single, somewhat damaged specimen of this species is before me. It superficially resembles *D. barycephala,* but the form is slightly more elongate, the pronotum is shorter, and the palae are very different. It may be separated from *D. personata* by the larger and more conically produced head, the narrower and more rugose pronotum, etc.

EXPLANATION OF PLATE III.

Fig. 1. *Diaprepocoris barycephala,* male, from Lucindale, South Australia.
„ 2. *Diaprepocoris personata,* male, from Swan River, Western Australia.
„ 3. *Diaprepocoris zealandiae,* female, from New Zealand.
„ 4. Dorsum of abdomen of *D, personata,* male.
„ 5. Anterior leg of *D. barycephala,* male.
„ 6. Anterior leg of *D. personata,* male.
„ 7. Anterior leg of *D. zealandiae,* female.
Figs. 1 to 4 enlarged 11 diameters; figs. 5 to 7 enlarged 36 diameters.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 15.—THE PEARSON ISLAND RAT AND THE FLINDERS ISLAND WALLABY.

By F. Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read April 10, 1924.]

Since the other papers of this series (Nos. 2 and 6) that deal with Mammals were written, two further mammalian forms have been added to the list of the island fauna. In both cases these animals belong to new species confined, so far as is known, to the islands upon which they were obtained.

The Pearson Island Rat.

In contribution No. 2, on the Monodelphian Mammals (vol. xlvi., 1922, p. 191), it was noted that "Pearson Island is probably the home of two Murines, and it is hoped that these species may one day be made known to science." It was suggested that two species were present because during a visit to the island on February 16, 1922, the present writer saw a rat, which appeared to be dark, almost bluish, in colour, between two granite boulders on Middle Island, and another member of the party reported having seen a light fawn-coloured rat on the open slope of North Island. As a result of fairly extensive trapping on the group during the longer visit of 1923, I have now no doubt that there is only one species of rat present, and the different impressions of the animal conveyed to two observers were due to different circumstances under which the brief view of the specimens was obtained. As a matter of fact, neither description is correct; the rat is not dark and bluish, as it appeared in the deep shade, nor is it pale and fawn coloured, as it appeared in the brilliant sunlight. Specimens captured during the 1923 visit were sent to Mr. Oldfield Thomas, at the British Museum, and by him they were described and named, in compliment to Sir George Murray, *Rattus murrayi.* The original description of the type specimen (Ann. and Mag. Nat. Hist., Ser. 9, vol. xi., p. 601, May, 1923) is as follows:—

Rattus murrayi.

"Most nearly allied to *R. greyi* of the mainland. Size about as in that animal. Fur fine and soft. General colour greyish washed with buffy-brown, the grey showing through the brown more than in *R. greyi,* and the general tone consequently paler. Under surface drabby-grey, the hairs broadly slaty at base, their tips drabby-whitish; line of demarcation scarcely marked. Hands and feet white, with a certain darkening on the metopodials and digits which is not present in *R. greyi.* Tail rather shorter than in *R. greyi,* but imperfect or diseased in most of the specimens, this being, perhaps, due to severe competition in a small island.

"Skull essentially similar to that of *R. greyi,* with similarly reduced supra-orbital ridges; but the palatal foramina are more widely open and the bullae are rather larger, the latter a character one would not expect to find in an island animal. Molars conspicuously smaller than in *R. greyi,* and, indeed, far smaller

in proportion to the skull than in the great majority of the species of *Rattus*. Dimensions of the type (measured on the spirit-specimen before skinning):— Head and body, 134 mm.; tail, 116; hind foot, 28; ear, 19. Skull: greatest length, 36·4; condylo-incisive length, 34; nasals, 14·6; interorbital breadth, 5; breadth of brain case, 15·2; palatal foramina, 7·5x3; length of bullae, 6·7; upper molar series, 5·1.

"This distinct species is readily recognizable by its pale colour, shortened tail, large bullae, and, most of all, by its unusually small teeth."

This little rat lives almost everywhere upon the three partially detached portions of the main island. Upon the South Island the whole of the travertine plateau is traversed by runaways which lead, radiating fashion, from central burrows which usually open into a large ramifying excavation beneath a slab of travertine. The runs are well beaten down, and traps set in them never failed to catch. Upon the open travertine plateau the rats seem mainly to feed upon the *Mesembryanthemum*, and none of their hollows beneath the travertine pavement contained any store of food.

On the Middle Island, and again on the larger North Island, the bulk of the rat population is centred on the travertine plateaux; but large communities also live among the great granite boulders. Wherever they shelter during the day time, the limestone flats, covered with pig-face and low saltbush, seem to provide their nocturnal playground and their source of food. In the one spot, on the southern and eastern side of Middle Island, where there is a sandy beach, the rats also come down to the sea shore every night to forage over the sand above the tide mark. Although, in the deep shade of the spaces between the great granite boulders, it is usually possible to see a specimen or two in the day time, the rats are distinctly crepuscular and nocturnal creatures, and as soon as dusk comes the travertine plateaux become alive with them. An evening rat hunt provided a never-failing source of amusement for the party camped on the island in 1923.

The animal proved to be ridiculously easy to trap, and in this it showed a very marked contrast to *Leporillus jonesi*, on Franklin Island. Cage traps set about the camp could be emptied and reset several times during the evening, and almost any bait—oatmeal, cheese, bacon, or bread—seemed to attract the rats. Those brought back alive lived well in captivity and proved to be very gentle and contented little animals; but, unfortunately, they did not breed. As in the case of some other animals observed in the islands, the males seem to vastly outnumber the females, and a very large proportion of the rat population shows varying degrees of mutilation of the tail. The general appearance of *R. murrayi* is very characteristic; its small size, fluffy coat, and small white hands and feet make it an attractive little animal. It is also remarkably gentle, and fresh-caught animals can be handled, if they are not unduly alarmed or roughly grasped, without fear of their biting. They thrive on any vegetable diet, but seem to be short lived, none of them remaining alive a year after capture and all of them showing well-marked signs of old age before they died.

The Flinders Island Wallaby.

In contribution No. 6, on the Didelphian Mammals (vol. xlvii., 1923, p. 92), it was recorded that the wallaby, which Flinders had seen on this island, and which was generally supposed to have become extinct, was, in fact, still living in small numbers upon the northern point of the island. During our stay on the island, in January, 1924, several specimens were seen and a male was shot and a female snared. The wallaby is one of the Dama group of the section *Thylogale*, and its cranial and external characters are sufficiently distinct from

those of other described members of the group to warrant its description as a new insular species. The animal is accordingly described here.

Thylogale flindersi, n. sp.

The description of the type, male, specimen is as follows:—

This is a gracefully-built wallaby of a general grizzled silver-grey colour.

It differs from the Kangaroo Island wallaby in being more finely built and considerably less sturdy. The head is small in proportion to the body, and the whole animal elegant compared with the thick-set wallaby of Kangaroo Island. The coat has a texture altogether different, in that it is fine, rather short and sleek, and lacks the woolly or fluffy appearance typical of *T. eugenii.*

In general colour it is markedly grizzled light grey, becoming strongly rufous over the shoulders in the male. The hairs of the mid-dorsal region measure 20 mm., and the long, entirely black, hairs which are so conspicuous in *T. eugenii* are absent. The individual hairs are banded with white instead of buff, and the majority of them lack the dark tip.

The face is grey, with a well-marked pale area extending along the upper lip to beneath the eye. Dorsal surface of the body, pepper-and-salt grey. Sides and back of neck and shoulders rather bright rufous in the male, tawny in the female. Upon the occiput there starts a dark mid-dorsal stripe; this stripe is very pronounced in the male and may be traced to the lower dorsal region. Chin and throat greyish-white; but the lower part of the neck, chest, and abdomen coloured almost as the dorsal surface, save that the pepper-and-salt mixture is somewhat lighter. Limbs pale fawn. Tail pale grey.

In the living animal the ears are pinkish-yellow within and but little hairy; without, they are clothed by dark-grey hairs. Vibrissae, etc., as in *T. eugenii.*

The skull is lightly built and is at once distinguished from that of *T. eugenii* by the narrow nasal bones, the outer margins of which are straight, or nearly so, in contrast to the sinuous outer margins of these bones in *T. eugenii.* The average breadth of the nasal bones is 13·7 mm. in *T. flindersi* as opposed to 19 mm. in the Kangaroo Island wallaby. The constriction of the interorbital region is also considerably narrower than that typical of the latter animal. In *T. flindersi* the average minimum breadth of the interorbital constriction is 14·2 mm. as opposed to 17·1 mm. in the other species. In the form of the nasal bones *T. flindersi* resembles *T. billardieri.*

Dimensions.	Type of Species: Male.	Female.
Head and body	570	510
Tail	410	340
Hind foot	132	118
Ear	47	50

DIMENSIONS OF SKULL.

	Male. Adult. Type:	S.A. Mus. No. 1751	Adult.	Adult.	Adult.	S.A. Mus. No. 1750	Adult.	S.A. Mus. No. 1749	Adult.
Basal length ..	95	92	88	87	85	85	84	84	79
Breadth	53	49	49	49	49	49	—	46	47
Nasals, length ..	38	36	34	34	34	32	—	34	33
Nasals, breadth ..	16	16	12	14	13	12	—	14	13
Interorbital breadth	14	14	13	14	14	15	14	15	15
Palate length ..	59	51	53	54	51	50	50	50	49
Diastema	20	19	17	19	19	19	17	17	19
MI-M3	18	17	18	16	18	16	18	15	15

For the purposes of comparison the following tables give measurements of skulls of *T. eugenii* from Kangaroo Island and from the mainland of South Australia:—

KANGAROO ISLAND SPECIMENS.

	Average of 50 male skulls.	Average of 40 female skulls.
Basal length	98·8	94·8
Breadth	54·5	52·8
Nasals, length	38·7	36·4
Nasals, breadth	19·2	18·9
Palate length	59·8	57·3
Interorbital constriction	17·1	17·1
Diastema	22·2	20·7
M1-M3	19	19

MAINLAND SPECIMENS: SOUTH AUSTRALIAN MUSEUM SKULLS.

	Pt. Linc'ln No. 1748	Tickera No 1755	Pt. Linc'ln No. 1740	Pt. Lincl'n Male. No. 1746
Basal length	92	88	84	82
Breadth	50	50	48	50
Nasals, length	35	35	35	30
Nasals, breadth	18	16	16	16
Palate length	54	51	55	55
Interorbital constriction	16	16	14·5	17·5
Diastema	23	17	20	22
M1-M3	17	17	17	15

Flinders observed this animal in 1802, and he states that on the island "a small species of kangaroo, not bigger than a cat, was rather numerous. I shot five of them, and some others were killed by the botanists and their attendants and found to be in tolerably good condition." Even comparatively recently the animal was very numerous, and it has been reported that as many as thirty thousand were at one time killed on the island. In 1910 a destructive bush fire swept the portion of the island occupied by wallabies, and when I visited the place in 1920 no trace of them was to be found, and the tenant of the island believed them to be extinct. In 1922 I again visited the island and found obvious evidence of their presence, but no actual specimen was seen.

During the time spent in camp on the island, in 1924, the study and collection of this wallaby were the principal objects to which I devoted attention. The tracks were again found in the same restricted area, and on the first visit to the spot one was heard to thump in the dense ti-tree which covers this, the northern, corner of the island. Owing to the thick growth of ti-tree it was extremely difficult to observe the animals or to shoot them, and without previous preparation, the site was not an easy one in which to snare. Only three animals were actually seen by the writer, and one, a male, was shot and a female snared. The animal is obviously more agile and quicker in its movements than the examples of *T. eugenii*, living on Kangaroo Island, and it appears to be a more elegant creature when moving about.

The present small colony of wallabies occupies only a very restricted area upon which the native bush has not been destroyed by various attempts at cultivation. Although it probably contains a hundred or so individuals, its hold on life cannot be considered a very secure one. The animals are always at the mercy of bush fires, having no line of retreat, since they live on a corner of the

island that is girt by high and inaccessible cliffs. Moreover, they have to contend against two introduced animals, the feral domestic cat, which has overrun the island, and the rabbit. They may at any time, though fortunately this does not seem to be at present the case, have to contend against human enemies. In January, 1924, the young were entirely independent of their mothers. On account of its build being rather more elegant than that of the thick-set Kangaroo Island wallaby, it was at one time a favourite with people who cared to have wallabies running in their grounds, but at present I believe there are no descendants of these animals living on the mainland. It has also been an inhabitant of the Zoological Gardens in Adelaide, but no specimens have been exhibited there for many years.

As mentioned in the previous paper (No. 6), a former tenant of the island (Mr. May) has assured me that when the wallabies were numerous there were two distinct types living on the island, the one obviously that described as *Thylogale flindersi,* and the other a more rare, slender, yellow wallaby. What this second animal was it is impossible to guess; there seem to be no traces of it left.

ON AUSTRALIAN ANOBIIDES (COLEOPTERA).

By Arthur M. Lea, F.E.S., Entomologist, South Australian Museum.
(Contribution from the South Australian Museum.)

[Read May 8, 1924.]

The species of the subfamily Anobiides of the Ptinidae, although including some important ones from an economic point of view, are nearly all small and dingy, and specimens of the sections Xyletininae and Dorcatominae are difficult to manipulate, so that parts of the under surface may be clearly seen, yet these must be examined before the genera can be noted with certainty. Very few Australian species of the subfamily have been previously named. The generic details given by Lacordaire [1] appear of little use, as he seldom mentioned parts of the under surface, in particular of the head and sterna, by which the Australian genera may be most satisfactorily distinguished; so for the main divisions reliance has been placed on Leconte and Horn.[2] That many of our genera occur in other parts of the world is certain, apart from introduced ones, so that some notes on generic features may be useful; the generic table, however, was prepared solely with a view to convenience of identification. Recently [3] a list was given of the species of the Ptinides, and it seems now desirable to give one of the Anobiides, based on M. Pic's catalogue of the subfamily.[4]

DRYOPHILINAE.

Dryophilodes australis, Blackb.
„ insignis, Blackb.
Dryophilus [5]

ERNOBIINAE.

Ernobius mollis, Linn.[6]

ANOBIINAE.

Sitodrepa panicea, Linn.
Anobium punctatum, De Geer.
domesticum, Fourc.
Hadrobregmus australiensis, Pic.
Trypopitys
Pronus magniventris, Lea
„ medianus, Lea

PTILININAE.[7]

XYLETININAE.

Lasioderma serricorne, Fab.

DORCATOMINAE.

Calymmaderus australiensis, Pic.
Thaptor [8]
Dorcatoma lanigera, Oll.[9]
Caenocara

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(1) Lacordaire, Gen. des Col., iv.
(2) Leconte and Horn, Class. Col. N. Am., 1883, in Smithsonian Misc. Col., No. 507.
(3) Lea, Trans. Roy. Soc. S. Austr., 1917, pp. 146, 147.
(4) Pic, in Junk's Col. Cat., part 48, Berlin, 1912.
(5) Olliff, Proc. Linn. Soc. N.S. Wales, 1888, p. 1512, records this genus as Australian, but without naming a species.
(6) Recorded as cosmopolitan, but specific Australian localities are herein noted.
(7) A new genus of the section herein noted *(Deroptilinus)*.
(8) Recorded by Pic as a synonym of *Calymmaderus*.
(9) Olliff, *l.c.*, p. 1511, overlooked by Pic; but herein proposed as the type of a new genus, *Aulacanobium*.

Australian Genera of Anobiides.

A. Head free, front coxae level with intercoxal process.
  a. Antennae simple .. .. *Dryophilodes*
  aa. Antennae with three apical joints greatly enlarged .. .. .. *Ernobius*
AA. Head with sides capable of being received in prosternal excavations, front coxae strongly projecting.
  B. Antennae with four joints ramose . .. . *Deroptilinus*
  BB. Antennae with three apical joints not greatly enlarged (the apical one at most moderately enlarged).
    b. Mesosternum with an open cavity, continued on to metasternum, for reception of antennae .. .. *Trypopitys*
    bb. Mesosternum not cavernous.
      c. Base of lower surface of head deeply bisinuate for reception of antennae .. .. *Lasioderma*
      cc Base not bisinuate or cavernous.
        d. With regular series of punctures on elytra .. .. .. *Tasmanobium*
        dd. Without such .. .. *Secretipes*
  BBB. Antennae with three apical joints much longer, and usually much wider, than the preceding ones.
    C. Base of lower surface of head deeply bisinuate for reception of antennae.
      e. Two basal joints of club each with a long ramus .. .. *Aulacanobium*
      ee. Club not ramose.
        f. Each side of prosternum with an exposed triangle .. .. *Dicoelocephalus*
        ff. Legs concealing sides of prosternum .. .. *Deltocryptus*
    CC. Base of lower surface of head not deeply bisinuate.
      D. Without a concealed sternal cavity.
        g. Mesosternum and metasternum with an open median cavity, common to both .. .. • .. .. .. *Anobium*
        gg. Sterna without an open median cavity.
          h. Rear flanks of prosternum oblique .. . . *Sitodrepa*
          hh. Rear flanks vertical .. .. *Pronus*
      DD. Front and middle coxae separated to allow passage of antennae into a concealed sternal cavity.
        E. First joint of club longer than two following combined .. *Calymmaderus*
        EE. First joint shorter.
          F. First joint of club of male with a process more than twice as long as its support .. .. *Caenocara*
          FF. Process not twice as long as its support .. .. .. *Dorcatoma*

Notes on Table.

aa. *Dryophilus* is allied to *Ernobius*, but I have not seen any Australian species, although Olliff records the genus as occurring in New South Wales.

AA. The head is usually seen resting on the breast, concealing part or all of the front legs.

Hadrobregmus has been recorded as Australian, but *H. australiensis* is an *Anobium*.

Dryophilodes.

The numerous small and dingy species, which I refer to this genus, certainly all belong to the Dryophilini, but it is probable that they will eventually be referred to several genera when the species can be compared with associated ones occurring elsewhere, and particularly with the New Zealand genus *Sphinditeles*, and similar genera, but at least they may all be referred to *Dryophilodes* by the generic table given herein. Much importance in the group is sometimes attached to the sides of the prothorax, so that *D. serricornis* and *D. marginicollis*, whose prothoracic margins are conspicuously wider than on all others, are almost certain to be considered as belonging to a different genus, or to two different genera. In the event of the genus being split up, *D. subcylindricus*, *D. vigilans*, *D. angustus*, and *D. minor* should be kept together, and *D. politus* and *D. subopacus*, which are certainly close to *Sphinditeles*, should also be kept together. The prothorax of many species, as viewed from in front, appears to have the

sides evenly arcuate from the base to the middle, then evenly rounded to the apex, but when viewed from behind, or from directly above the scutellum, each side appears to be acutely produced in the middle, or even spinose; but the apparent acuteness varies so much with the point of view, and the gradations between the extremes of the genus are so gradual, that they cannot be employed for the major divisions of a table, although often useful for distinguishing some of the species. The hind angles are sometimes produced to the sides, when, if small, they are not easily seen, and so the prothorax may appear to have obtuse basal angles, sometimes they are produced slightly backwards, on to the elytra near the shoulders, on such specimens they usually appear decidedly acute, although they may be actually 90 degs. or more. On most species the hind angles are more densely clothed than the rest of the prothorax, frequently appearing whitish, but as the pubescence is easily abraded or disarranged not much reliance can be placed upon it; the density of the pubescence also makes an apparent difference, except on close examination, to the degrees of the angles and the arcuation of the sides. The lineate arrangement of the elytral punctures is conspicuous on some species, and faintly or not at all traceable on others, but, even when not traceable elsewhere, a faint lineate arrangement on the basal slope may appear or disappear from various points of view. I have not usually considered it necessary to describe more than the colour of the under surface, but the parts of all species were examined; the apical half of the metasternum has a deep median line, and, unless otherwise mentioned, the apical segment of the abdomen is either flat, or has a more or less shallow median impression; it may sometimes be used for distinguishing the sexes, but not commonly so. All the species have the head with small crowded punctures, often partially concealed by pubescence. The eyes are always prominent, but vary in size from small to moderately large. Many of the species may be beaten from eucalyptus foliage affected by various kinds of gall-insects.

TABLE OF SPECIES OF DRYOPHILODES.

A. Elytral pubescence forming more or less conspicuous markings.
- *a*. Elytral pubescence mostly pale, with a large dark patch on suture
  - *b*. Sutural patch as in fig. 1 .. .. *insignis*
  - *bb*. Sutural patch as in fig. 2 .. .. *pyrifer*
  - *bbb*. Sutural patch as in fig. 3 .. .. *sagittifer*
- *aa*. Elytral pubescence not as in *a*.
  - *c*. Pubescence in irregularly alternate golden and white vittae .. *pictus*
  - *cc*. Three transverse series of small spots .. . . .. *latus*

AA. Elytral pubescence uniform or almost so.
- B. Antennae conspicuously serrated .. .. *serricornis*
- BB. Antennae filiform, or at most feebly serrated.
  - C. Sides of prothorax distinctly arcuate towards base, hind angles acute.
    - *d*. Basal third of prothorax completely clothed with white pubescence .. .. *basicollis*
    - *dd*. Base of prothorax without white pubescence, or only in angles.
      - *e*. Elytral pubescence longer than usual, and lineate in arrangement .. .. *pilipennis*
      - *ee*. Elytral pubescence short and uniform.
        - *f*. Elytral punctures not distinctly seriate in arrangement on basal half.
          - *g*. Apical segment of abdomen conspicuously bifoveate .. *bifoveiventris*
          - *gg*. Abdomen not bifoveate.
            - *h*. Prothorax not at all black.
              - *i*. Sides of prothorax viewed directly from above conspicuously angulate in middle.
                - *j*. Size moderate .. .. *squalidus* (in part)
                - *jj*. Size small .. .. *orthodoxus*
              - *ii*. Sides of prothorax, so viewed, not angulate in middle .. .. *metasternalis*

hh. Prothorax partly or entirely black.
k. Without a finely impressed line at base of pronotum .. *murinus*
kk. A finely impressed line at base of pronotum.
l. All joints of antennae conspicuously longer than wide .. .. *acuticollis*
ll. Some of the median joints of antennae very little or not at all longer than wide.
m. Size moderate .. .. *squalidus* (in part)
mm. Size minute .. .. *parvoniger*
ff. Elytral punctures, at least on basal half, more or less seriate in arrangement.
n. Prothorax black.
o. Bases of prothorax and of elytra of two contrasted shades of colour .. .. *brunneipennis*
oo. Bases similarly coloured.
p. Length less than 3 mm. .. .. *apicipennis*
pp. Length 3 mm. or more.
q. Elytra more than thrice the length of prothorax *eucalypti*
qq. Elytra not thrice the length of prothorax .. *acutangulus*
nn. Prothorax at most dark brown.
r. Each elytron at base wider than median length of prothorax .. .. *brevicollis*
rr. Each elytron narrower than median length of prothorax.
s. Seriate punctures of elytra not distinct to middle .. *subhumeralis*
ss. Seriate punctures distinct to beyond middle.
t. Sides of prothorax, as viewed obliquely from behind, apparently spinose.
u. Interstices on basal half of elytra asperate-punctate or granulate .. .. *rufobrunneus*
uu. Interstices there smoother .. .. .. *seriatus*
tt. Sides of prothorax, viewed as in *t*, not apparently spinose.
v. Elytra quite parallel-sided from behind shoulders to near apex.
w. Elytral pubescence extremely short (dust-like) *pulverulentus*
ww. Elytral pubescence short but not abnormally so.
x. Interstices between rows of punctures with a granulated appearance .. .. .. *interstitialis*
xx. Interstices without a granulated appearance *flavipalpis*
vv. Elytra with slightly rounded sides .. .. *melanostethus*

CC. Sides of prothorax scarcely or not at all arcuate towards base, hind angles 90 degs. or more.
D. Elytral punctures not distinctly lineate in arrangement.
y. Thin .. .. *subcylindricus*
yy. Comparatively robust.
z. Greatest width of prothorax slightly more than that of of elytra .. .. *fumosus*
zz. Greatest width of prothorax not more than that of elytra
a. Derm of elytra not black .. .. *robustus*
aa. Derm of elytra black, except on part of apical slope.
b. Pubescence short and depressed .. .. *niger*
bb. Pubescence longer and looser .. .. *pullatus*
DD. Elytral punctures more or less distinctly lineate in arrangement.
E. Comparatively robust.
c. Pubescence white or almost so, and very dense .. .. *albatus*
cc. Pubescence darker and less dense.
d. With two shallow medio-basal depressions on pronotum *multiseriatus*
dd. Without such.
e. Derm of prothorax and elytra of two contrasted shades of colour.
f. Elytra scarcely twice as long as wide .. .. *latipennis*
ff. Elytra more than twice as long as wide .. .. *brevicornis*
ee. Derm of prothorax and elytra not of contrasted shades of colour.

g. Prothorax with conspicuous lateral margins .. *marginicollis*
gg. Prothorax with feeble lateral margins.
h. Prothorax with denser and paler clothing on hind angles than on disc .. .. *ubiquitosus*
hh. Prothorax without special clothing on hind angles.
i. Prothorax black .. .. *obscuripennis*
ii. Prothorax not black.
j. Size minute .. .. *abjectus*
jj. Size larger.
k. Many joints of antennae scarcely longer than wide .. .. *australis ?*
kk. All joints except the second distinctly longer than wide .. .. *subapicalis*
EE. Comparatively thin.
F. Prothorax entirely black.
l. Seriate arrangement of elytral punctures feeble.
m. Pubescence very short and depressed .. .. .. *vigilans*
mm. Pubescence longer and sloping .. .. .. *planicollis*
ll. Seriate arrangement of elytral punctures distinct.
n. Greatest width of prothorax equal to base of elytra .. *nigrinus*
nn. Greatest width of prothorax less than base of elytra.
o. Upper surface shining .. .. *politus*
oo. Upper surface subopaque .. .. *subopacus*
FF. Prothorax at most partly black.
G. Greatest width of prothorax equal to base of elytra.
p. Pubescence very short and depressed .. .. .. *angustus*
pp. Pubescence with a looser appearance .. .. .. *minor*
GG. Greatest width of prothorax less than base of elytra.
H. Prothorax from some directions with a distinct median line .. .. *cribripennis*
HH. Without such.
I. Lineate arrangement of elytral punctures distinctly traceable to beyond the middle .. .. .. *parvicollis*
II. Lineate arrangement not traceable to middle; size much smaller .. .. *pallidus*

Notes on Table.

aa. Specimens of these species, in good condition, are very distinct, but the pubescence appears to be easily disarranged or abraded.

C. The point of view should be from immediately above the scutellum; on these species the arcuation of the sides of the prothorax is distinct in itself, although sometimes apparently enhanced by clothing, the hind angles are also less than 90 degs. Seen from behind the sides appear angulate in middle. On the species of CC the clothing may sometimes cause the sides to appear arcuate, although they are really not so, and the angles are usually more than 90 degs. When the angles are greasy or dusty, however, it is sometimes difficult to decide as to their degrees; *D. parvoniger* at first glance appears to have the hind angles more than 90 degs., but on close examination they are seen to be acute, with the sides before them arcuate.

f. In some lights about the basal fourth of *D. squalidus* a faint lineate arrangement appears from certain directions, but on the species of *ff* the seriate arrangement is fairly distinct to the middle, or beyond it.

g. This character may be confined to the male, but the species is otherwise distinct.

i. On these species, as on many others of the genus, the sides of prothorax when viewed from directly above or behind the scutellum, appear to be quite strongly angulate in the middle, or even almost spinose, but on altering the point of view to a more frontal one this appearance is lost.

ii. All the specimens referred to *D. metasternalis* appear to belong to but one species, but on some of them a faintly lineate arrangement of the punctures

may be traced. The hind angles, viewed from above the scutellum, certainly appear slightly less than 90 degs., but the arcuation of the sides before the base is feeble.

q. There are other differences between *D. eucalypti* and *D. acutangulus*, particularly in the pronotum and length of antennae, but the comparative lengths of the prothorax and elytra are at once apparent when specimens of the two species are placed side by side.

r. This is a comparatively robust species, but to appreciate the character used to distinguish it from those of *rr*, it is necessary to hold specimens at such a point that the front edge of the prothorax is clearly visible.

s. It was with some doubts that this species was placed with others of *ff*, as the seriate punctures are but feebly defined even near the base. The specimens, however, have a dark or velvety patch on each side behind the shoulder, that is fairly distinct from some directions, although it is not due to pubescence.

t. On these species the sides of the prothorax, from an angle of about 45 degs. behind the scutellum, appear to be very sharp, even spinose; on those of *tt*, from the same point of view, the sides appear to be moderately produced, but certainly not spinose.

z. *D. fumosus* was somewhat doubtfully placed here; see notes under its description.

DD. The lineate arrangement of the elytral punctures is usually sufficiently distinct on the basal half, but on many species it becomes vague posteriorly, and on a few it is not very sharp even towards the base, although a lineate arrangement is certainly traceable in parts.

ee. This may only refer to the base of the elytra, which is as dark as the prothorax.

GG. The two species here associated are sufficiently distinct when placed side by side, but it is rather difficult to define the differences except in length and clothing; there are eight of *D. minor* before me, all taken together, on some of them the prothorax is black with only the front edge obscurely reddish, so that they might have been referred to F, where they would be associated with *D. vigilans*, a much larger and otherwise different species.

Dryophilodes australis, Blackb.

A Victorian specimen, measuring 3 mm., was standing in the Blackburn collection as *D. australis*, although without a name-label actually transfixed by its pin. It differs from the description in being of an uniform dull castaneous-brown (not piceous with some parts paler), and with fairly large and close-set rows of punctures, distinct to well beyond the middle (on the sides almost to the apex); the elytra were described as *"obsoletissime striatis,"* and those of the specimen in question might fairly be so regarded in comparison with other beetles, but for the genus the rows are unusually distinct. The specimen has been included in the table as *australis ?*, as its identity is certainly doubtful.

Dryophilodes insignis, Blackb. Fig. 1.

One of the few strikingly marked species of the subfamily. It varies somewhat in size, and is widely distributed, specimens before me being from northern Queensland, New South Wales (Wollongong, National Park, Forest Reefs), Victoria (Nelson), South Australia (Gawler, Mount Lofty, Port Lincoln), and Western Australia (Garden Island).

Dryophilodes pyrifer, n. sp. Fig 2.

Piceous-brown, abdomen and parts of legs obscurely reddish. Densely clothed with whitish scales, obscurely variegated on head and prothorax, elytra with a conspicuous somewhat pear-shaped velvety patch of darker scales, and with faint stripes, three median segments of abdomen each with a conspicuous apical fringe.

Head with large prominent eyes. Antennae with second joint rather small, third to tenth subequal in length but slightly diminishing in width, eleventh about half as long again as tenth. Prothorax not much wider than long, sides slightly arcuate towards base, hind angles somewhat acute, densely and finely granulate. Elytra distinctly wider than prothorax, parallel-sided to near apex; with regular rows of punctures, almost concealed by clothing. Length, 4 mm.

Hab.—Tasmania: Stanley, on top of "Nut" (A. M. Lea).

At first glance apparently belonging to *D. insignis*, but decidedly larger, prothorax longer in proportion, and velvety patch of elytra with a parallel-sided extension to about one-fourth from the base. The head of the type has not been abraded, but appears to be densely granulate or punctate; where the prothorax has been abraded it is seen to be closely covered with small granules.

Dryophilodes sagittifer, n. sp. Fig. 3.

Piceous-brown, abdomen, legs, and antennae more or less obscurely reddish. Densely clothed with white or whitish scales, on the upper surface variegated with fawn-coloured ones; the elytra, in addition, with a conspicuous velvety patch in middle.

Eyes rather large and prominent. Antennae moderately long. Prothorax not much wider than long, sides moderately rounded, gently arcuate towards base, hind angles almost square, derm concealed. Elytra rather narrow, distinctly wider than prothorax, parallel-sided to near apex; with rows of normally almost concealed punctures. Length, 2·75-3 mm.

Hab.—Queensland: Dalby (Mrs. F. H. Hobler); New South Wales: Sydney (A. M. Lea).

A beautiful little insect, allied to *D. insignis*, and the preceding species, but smaller, and with the velvety patch of different shape, being acutely produced in front and notched posteriorly, so as to be shaped somewhat like an arrow-head; it is also usually conspicuously bordered by snowy scales; beyond the velvety patch each elytron has white and fawn-coloured scales (varying in extent with the specimen), and with darker patches sublineately arranged, as if remnants of vittae. The derm of the head and prothorax is normally concealed, but is apparently covered with small punctures or granules. The hind angles of the prothorax, viewed from above the scutellum, appear to be square, but from a point perpendicular above each, they are seen to be slightly more than 90 degs.

Dryophilodes pictus, n. sp.

Reddish-castaneous. Clothed with golden-red and whitish pubescence, more or less vittate on elytra; under surface with whitish pubescence.

Antennae moderately long, second joint small, none of the others transverse. Prothorax moderately transverse, sides scarcely arcuate towards base, hind angles slightly more than 90 degs.; punctures crowded, small, and normally concealed; with a faint median line. Elytra slightly wider than prothorax, not quite parallel-sided; with dense punctures, nowhere distinctly seriate in arrangement. Length, 3·25-4 mm.

Hab.—South Australia: Adelaide (J. G. O. Tepper), Tumby Bay (Rev. T. Blackburn), Ooldea (A. M. Lea); Western Australia: Swan River (Lea).

A robust species. On specimens in good condition the pubescence is beautifully variegated, but on partial abrasion it appears speckled, instead of longitudinally striped. On the specimens from Tumby Bay and Ooldea the metasternum is almost black, on the others it is not at all, or scarcely, darker than the abdomen.

Dryophilodes latus, n. sp.

Castaneous-brown, metasternum and other parts sometimes darker. Moderately clothed with somewhat yellowish pubescence, becoming white on under surface, and obscurely maculate on elytra.

Antennae moderately long. Prothorax about once and two-thirds as wide as long, sides moderately rounded, hind angles more than 90 degs., median line faint; punctures crowded and small. Elytra slightly wider than widest part of

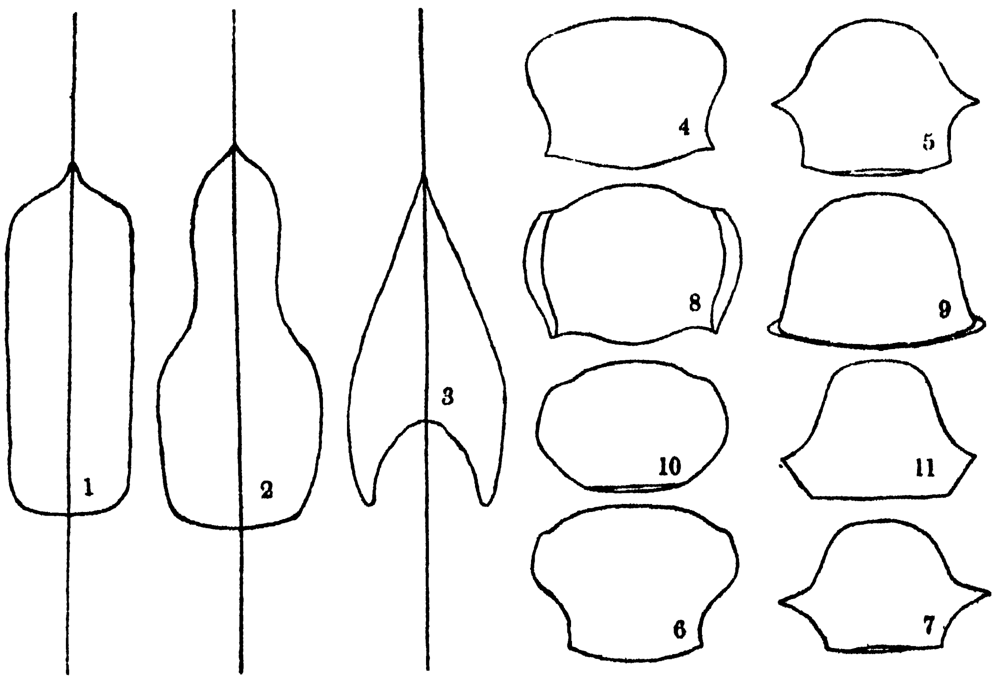
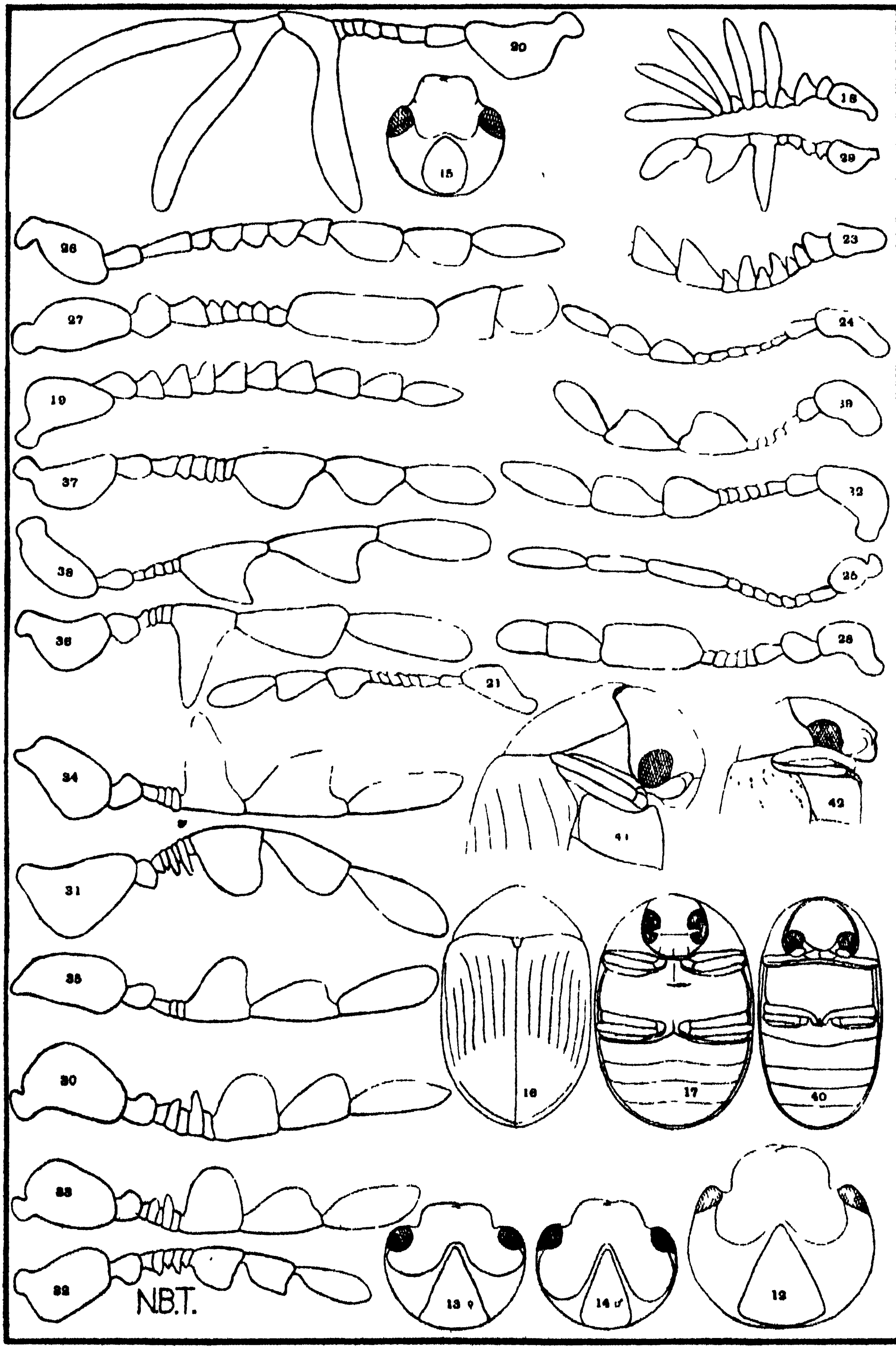


Fig. 1, Pattern of elytral marking of *Dryophilodes insignis,* Blackb.; 2, of *D. pyrifer,* Lea; 3, of *D. sagittifer,* Lea; 4, prothorax of *D. acuticollis,* Lea, as viewed from in front; 5, from behind; 6, *D. seriatus,* Lea, from in front; 7, from behind; 8, *D. marginicollis,* Lea, from in front; 9, from behind; 10, *D. cribripennis,* Lea, from in front; 11, from behind; 12, under surface of head of *Lasioderma serricorne,* Fab.; 13 and 14, of *Aulacanobium lanigerum,* Oll.; 15, of *Deltocryptus punctiventris,* Lea; 16 and 17, of *Dorcatoma irrasa,* Lea; 18, antenna of *Deroptilinus granicollis,* Lea; 19, of *Secretipes xanthorrhoeae,* Lea; 20, of *Aulacanobium lanigerum,* Oll.; 21, of *Dicoelocephalus granipennis,* Lea; 22, of *D. obscurus,* Macl.; 23, of *Deltocryptus punctiventris,* Lea; 24, of *D. inamoenus,* Lea; 25, of *Anobium areolicolle,* Lea; 26, of *Pronus subhumeralis,* Lea; 27, of *Calymmaderus pulverulens,* Lea; 28, of *C. inconspicuus,* Lea; 29, of *Caenocara insignicornis,* Lea; 30, of *Dorcatoma intreroculari*s, Lea; 31, of *D. irrasa,* Lea; 32, of *D. tasmaniensis,* Lea; 33, of *D. modica,* Lea; 34, of *D. antennalis,* Lea; 35, of *D. punctipennis,* Lea; 36, of *D. subcircularis,* Lea; 37, of *D. punctilatera,* Lea; 38, of *D. rhizobioides,* Lea; 39, of *D. elliptica,* Lea; 40, under surface of *Secretipes xanthorrhoeae,* Lea; 41, side view of *Dicoelocephalus granipennis,* Lea; 42, of *Deltocryptus punctiventris,* Lea.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prothorax, almost parallel-sided to beyond the middle; punctures crowded and nowhere lineate in arrangement. Length, 3·25-4·25 mm.

Hab.—South Australia: Adelaide (A. H. Elston and J. G. O. Tepper), Mount Lofty (Tepper); Western Australia: Geraldton (A. M. Lea).

A robust and rather dingy species, with outlines much as on the preceding one, but differently clothed; the elytra are more densely pubescent or maculate about the base, middle, and near apex than elsewhere, and have the appearance as of being irregularly abraded, but as they are alike on the seven specimens before me (including two taken quite recently) this appearance is evidently natural. On several specimens the abdomen and metasternum are no darker than the elytra, but the metasternum is usually somewhat darker; on one Adelaide specimen the sterna and abdomen are entirely black, and the prothorax, except in front, is rather deeply infuscated; the specimen from Geraldton is similar to the Adelaide one mentioned, except that it is smaller, and that the head is also infuscated.

Dryophilodes serricornis, n. sp.

Black; abdomen and posterior, three-fourths of elytra obscurely diluted with red; antennae, palpi, and tarsi reddish. Clothed with short, depressed, blackish pubescence, becoming somewhat longer and paler on abdomen.

Eyes prominent but not very large. Antennae not very long, second and third joints small, fourth to tenth serrated, eleventh slightly longer than tenth. Prothorax about once and two-thirds as wide as long, sides distinctly margined, base with a deeply impressed line but interrupted in middle, median line feeble but traceable throughout; punctures crowded and small. Elytra no wider than prothorax, parallel-sided to near apex; with crowded and small punctures, nowhere lineate in arrangement, but becoming rather coarse near base. Metasternum with median line from apex to base. Abdomen large, second and fifth segments slightly longer than the others. Length, 4 mm.

Hab.—Queensland: Mount Tambourine (A. M. Lea).

From some directions the elytra and abdomen appear to be entirely black. The distinctly serrated antennae and comparatively wide prothoracic margins are at variance with most species of the genus, but it does not appear desirable to propose a new genus for the reception of the single specimen taken.

Dryophilodes basicollis, n. sp.

Black; elytra and abdomen sometimes obscurely diluted with red; antennae, palpi, and parts of legs somewhat reddish. Clothed with short depressed pubescence, becoming conspicuously whitish across basal third of prothorax.

Eyes small and prominent. Antennae moderately long, first and eleventh joints longer than the others, these not much longer than wide. Prothorax moderately transverse, sides rather strongly rounded in front, and distinctly arcuate towards base, hind angles acute, median line not traceable; punctures crowded and small. Elytra no wider than widest part of prothorax, parallel-sided to near apex; with crowded punctures, nowhere distinctly seriate in arrangement. Apical segment of abdomen with a median depression, on each side of which is a small protuberance. Length, 2·25-2·75 mm.

Hab.—South Australia: Poonindie (Rev. T. Blackburn), Quorn (A. H. Elston), Ardrossan (J. G. O. Tepper), Murray Bridge; Tasmania: Mount Wellington (A. M. Lea).

On specimens in good condition the white pubescence is conspicuous across the entire base of prothorax, but it is comparatively easily disarranged; in some lights the elytra appear to have a median fascia of white pubescence, but it is never sharply defined, and varies with the point of view. On two specimens the derm of the elytra is entirely black, but on the others its apical two-thirds,

or less, is obscurely diluted with red; the abdomen also varies from entirely black to obscurely reddish. The Murray Bridge specimen has distinctly longer antennae than the others, and the apical segment of its abdomen is simple; the differences are probably sexual.

Dryophilodes pilipennis, n. sp.

Blackish-brown; head, under surface, antennae, palpi, and legs more or less obscurely reddish. Rather densely clothed with stramineous pubescence, longer on elytra than elsewhere, and converging to form lines.

Eyes prominent and rather large. Antennae moderately long and rather thin. Prothorax moderately transverse, sides, as viewed from above, strongly rounded in front, and strongly arcuate towards base, hind angles acute; with crowded punctures. Elytra parallel-sided to near apex; with dense and rather sharply defined punctures, of which some rather larger ones are formed into numerous distinct series. Length, 3·5 mm.

Hab.—South Australia: Lucindale (B. A. Feuerheerdt).

The lineate arrangement of the elytral pubescence and punctures is quite distinct. From behind there appears to be a faint but distinct Y on the prothorax, as the view is altered to a more forward one the Y alters to a V; but many other species appear to have similar Y's and V's.

Dryophilodes bifoveiventris, n. sp.

Deep black and subopaque; parts of antennae, of abdomen, and of legs obscurely diluted with red, palpi flavous. With short depressed pubescence, dark on the upper surface, pale on the under surface.

Antennae not very long, first and eleventh joints moderately long, the others not at all, or scarcely, longer than wide. Prothorax moderately transverse, sides strongly rounded in front and arcuate towards base, hind angles acute; punctures as on head. Elytra no wider than widest part of prothorax, parallel-sided to near apex, with a shallow longitudinal depression in middle of each; punctures crowded and nowhere distinctly lineate in arrangement. Abdomen with a large, round, shining fovea on each side of the apical segment. Length, 3·5 mm.

Hab.—Victoria: Birchip (J. C. Goudie, No. 300).

The abdominal foveae may be confined to one sex, but the species is otherwise distinct by its deep-black colour, and by the longitudinal depressions on the elytra. At first glance the hind angles of the prothorax appear to be rounded off, but they are really small and acute.

Dryophilodes orthodoxus, n. sp.

Dark brown or piceous-brown; antennae, palpi, and usually the abdomen, paler. Moderately clothed with pale pubescence.

Eyes small and very prominent. Antennae not very long. Prothorax moderately transverse, sides as viewed from above somewhat angulate in middle and arcuate towards base, hind angles acute, a finely impressed line at median base; punctures slightly larger than on head. Elytra at base no wider than prothorax, almost parallel-sided to near apex; with crowded punctures, larger towards base than elsewhere. Length, 1·75-2 mm.

Hab.—New South Wales: Galston (D. Dumbrell), Sydney, Tamworth, Dalmorton (A. M. Lea).

Structurally close to *D. murinus,* but smaller, less densely clothed, and prothorax with the usual finely impressed line across the median base; *D. parvoniger* is narrower, and with the sides of prothorax different, in addition to

being darker. In some lights the punctures about the shoulders appear to be obsoletely seriate in arrangement, and the interstices there to be granulate instead of punctate.

Dryophilodes metasternalis, n. sp.

Dull castaneous-brown; metasternum, and sometimes the abdomen, darker. Moderately clothed with pale depressed pubescence, usually denser in hind angles of prothorax.

Eyes prominent but rather small. Antennae moderately long. Prothorax moderately transverse, sides, as viewed from above, rather suddenly deflected from middle to apex, somewhat arcuate towards base, hind angles somewhat acute. Elytra slightly wider than prothorax, parallel-sided to near apex; with crowded and small punctures, nowhere distinctly seriate in arrangement. Length, 1·75-2·5 mm.

Hab.—South Australia: Tumby Bay (Rev. T. Blackburn), Parachilna (H. M. Hale), Lucindale (B. A. Feuerheerdt); New South Wales; Wollongong, Sydney (A. M. Lea); Queensland: Dalby (Mrs. F. H. Hobler).

The metasternum is usually darker than the abdomen and is sometimes almost black, as is occasionally the base of the abdomen. From some directions the pronotum appears to have a small median elevation near the base; the punctures on the basal third of elytra are larger than elsewhere, and from some directions cause the surface to appear granulate.

Dryophilodes murinus, n. sp.

Dark piceous-brown or blackish; antennae, legs, and sometimes the abdomen, obscurely reddish. Densely clothed with short, depressed, pale (but not white) pubescence, denser on basal half of median line, on hind angles of prothorax, and on scutellum than elsewhere.

Eyes small and prominent. Antennae thin, but not very long. Prothorax moderately transverse, sides, as viewed from above, somewhat produced in middle and distinctly arcuate towards base, hind angles acute; punctures crowded and normally almost concealed. Elytra at base slightly wider than prothorax, not quite parallel-sided to near apex; with crowded and rather small punctures, nowhere distinctly seriate in arrangement, and larger on and about shoulders than elsewhere. Length, 2-2·5 mm.

Hab.—Tasmania: Huon River; New South Wales: Sydney (A. M. Lea).

Structurally fairly close to the preceding species, but slightly more robust, darker, and with denser clothing. From some directions a subtriangular space on each shoulder appears less shining than the rest of the elytra, but this is mostly due to the larger punctures there. The absence of a finely impressed line across the median base of the pronotum is rare in the genus. The specimen from Sydney has the legs black and the pubescence of the upper surface somewhat looser, but the latter feature may be due to accident.

Dryophilodes acuticollis, n. sp. Figs. 4, 5.

Black, opaque; antennae, legs, and abdomen dull reddish, palpi paler. With very short pale pubescence, denser on hind angles of prothorax and on scutellum than elsewhere.

Eyes small and very prominent. Antennae rather long and thin. Prothorax scarcely wider at base than the median length; sides, as viewed from above, acutely produced in middle, and distinctly arcuate to base, with the hind angles acute, a faint ridge along middle; punctures as on head. Elytra conspicuously wider than base of prothorax, parallel-sided to near apex; with crowded punctures, nowhere seriate in arrangement, but somewhat larger about

shoulders than elsewhere. Abdomen with a medio-apical impression, on each side of which is a small acute prominence. Length, 2·75-3 mm.

Hab.—Tasmania: Hobart (A. M. Lea).

The type appears to be a male. A second specimen, from Hobart, is probably a female, as its abdomen is simple, it is smaller than the type, the elytra vaguely diluted with red posteriorly, and the metasternum no darker than the abdomen. A specimen from Forest Reefs (New South Wales) appears to be another female of the species, but has the under surface black. The prothorax of all the specimens, when viewed from above, or from behind the scutellum, appears to have the sides acute or even spinose in the middle, but from a frontal view the sides appear rounded from the middle to the apex.

Dryophilodes parvoniger, n. sp.

Deep black; antennae, palpi, and legs reddish. Clothed with short, depressed, ashen pubescence.

Eyes small and prominent. Antennae rather short, only the first and eleventh joints conspicuously longer than wide. Prothorax moderately transverse, sides rounded in middle and arcuate towards base, hind angles somewhat acute; punctures slightly larger than on head. Elytra very little wider than widest part of prothorax, parallel-sided to near apex; with crowded punctures, near base obscurely lineate in arrangement and larger than elsewhere. Length, 2 mm.

Hab.—New South Wales: Galston (A. M. Lea).

A small, comparatively narrow, black species; in some lights the abdomen appears obscurely reddish.

Dryophilodes brunneipennis, n. sp.

Black; elytra dingy brown; antennae, palpi, and legs paler. With depressed pale pubescence.

Eyes small and prominent. Antennae not very long Prothorax not much wider than long; sides, as viewed from above, somewhat prominent in middle, distinctly arcuate towards base, hind angles acute; punctures slightly coarser than on head. Elytra slightly wider than widest part of prothorax, parallel-sided to near apex; with dense punctures, somewhat asperate and larger on basal half than elsewhere, and more or less lineate in arrangement, except on parts of the apical slope. Length, 2·25-3 mm.

Hab.—South Australia: Lucindale (B. A. Feuerheerdt), Mount Lofty (A. H. Elston and J. G. O. Tepper); Western Australia: Geraldton (A. M. Lea); Tasmania: Mount Wellington (Lea).

The apex of the prothorax is usually narrowly reddish, the abdomen is sometimes as black as the metasternum, but is often obscurely reddish, the femora are somewhat infuscated in the middle; on several specimens the sides below the shoulders are slightly infuscated. A vague median line may mostly be traced on the apical half of the pronotum, and sometimes a vague oblique impression on each side of the middle near base. The lineate arrangement of the elytral punctures is distinct from many directions, but from some points of view the shoulders appear to be covered with small crowded granules. The specimen from Geraldton is rather thinner, and has slightly longer antennae and pubescence than usual.

Dryophilodes apicipennis, n. sp.

Black; antennae, palpi, and parts of legs reddish, elytra more or less reddish about apex. With short, depressed, pale pubescence.

Eyes small and very prominent. Antennae moderately long, none of the joints transverse. Prothorax moderately transverse, sides prominent in middle,

arcuate towards base, hind angles acute, median line fairly distinct, a feeble oblique impression on each side of middle towards base; punctures larger than on head. Elytra slightly wider than widest part of prothorax, parallel-sided to near apex; with fairly large asperate punctures, in rows about basal half and on sides, becoming smaller and irregular posteriorly. Length, 2-2·5 mm.

Hab.—South Australia: Mount Lofty (S. H. Curnow, A. H. Elston, and J. G. O. Tepper).

Structurally rather close to the preceding species, but elytra deep black except posteriorly, where on two specimens they are obscurely diluted with red, and on two others distinctly reddish.

Dryophilodes eucalypti, n. sp.

Black, opaque; abdomen and tarsi obscurely reddish, palpi paler, elytra obscurely diluted with red posteriorly. Moderately clothed with short, depressed, dingy pubescence.

Eyes prominent and moderately large. Antennae rather long, all the joints distinctly longer than wide. Prothorax very little wider at base than the median length; sides, as viewed from above, acute in middle and arcuate to base, hind angles acute and overhanging elytra; with crowded, but fairly sharply defined punctures. Elytra scarcely wider than widest part of prothorax, parallel-sided to near apex; with close-set rows of asperate punctures, becoming smaller, more crowded and irregular posteriorly. Length, 3·5-4·25 mm.

Hab.—Victoria: Seaford, numerous specimens reared from eucalyptus galls (J. F. Dixon), Birchip (J. C. Goudie).

On several specimens the abdomen is almost as black as the metasternum; the antennae are entirely black, or with only the apical joints obscurely reddish. From some directions there appears to be a feeble pubescent Y on the pronotum; seen directly from above the scutellum, or from a more posterior point, the sides of the prothorax appear to be acutely produced, but from in front they are seen to be quite evenly rounded on the apical half.

Dryophilodes acutangulus, n. sp.

Black, in parts subopaque; elytra obscurely diluted with red posteriorly, antennae, palpi, legs, and abdomen dull reddish, sterna somewhat darker. Clothed with short, depressed, pale pubescence.

Eyes small and very prominent. Antennae moderately long, a few of the joints scarcely longer than wide. Prothorax moderately transverse; sides, as viewed from above, rather acutely produced in middle, strongly arcuate to base, hind angles acute; punctures slightly larger than on head, appearing like small granules from some directions. Elytra comparatively short, no wider than widest part of prothorax, parallel-sided to near apex; with crowded and small punctures; in addition, except posteriorly, with rows of fairly large asperate ones. Length, 3·5 mm.

Hab.—New South Wales: Forest Reefs (A. M. Lea).

The head and prothorax are about as large as on the preceding species, but the elytra, although of the same width, are distinctly shorter, as a result the species is wider in proportion; the hind angles of the prothorax are quite as acute as on that species, but they are produced outwards, instead of slightly overhanging the elytra.

Dryophilodes brevicollis, n. sp.

Dull brown and subopaque; antennae, palpi, and legs paler. Moderately clothed with short, depressed, pale pubescence.

Head more convex in middle than usual. Eyes of moderate size and very prominent. Antennae not very long, but all the joints, except the second, longer than wide. Prothorax almost twice as wide as long, sides strongly rounded in front, arcuate towards base, hind angles acute and slightly overhanging elytra, median line fairly distinct; punctures crowded and small. Elytra comparatively short, distinctly wider than prothorax, almost parallel-sided to near apex; with fairly regular rows of asperate punctures, the rows almost vanishing posteriorly, the interstices everywhere with small crowded punctures. Length, 3 mm.

Hab.—South Australia: Lucindale (B. A. Feuerheerdt).

A rather wide species, structurally fairly close to *D. acutangulus*, but differently coloured. Two specimens from New South Wales (Forest Reefs and Armidale, A. M. Lea) probably belong to the species, but have most of the pronotum deeply infuscated, almost black, and the elytra also deeply infuscated, except on the sides (very narrowly) and along the suture

Dryophilodes subhumeralis, n. sp.

Dull piceous-brown; legs, abdomen, and hind parts of elytra more reddish; with short, depressed, and mostly pale pubescence.

Eyes small and very prominent. Antennae rather long and thin, none of the joints transverse. Prothorax at base scarcely wider than the median length; sides, as viewed from above, acutely angulate in middle and arcuate to base, hind angles acute; median line faint in front, slightly raised posteriorly; punctures as crowded as on head but slightly larger. Elytra distinctly wider than prothorax, parallel-sided to near apex; with crowded punctures, becoming larger and with a granulate appearance about base, about and for a short distance behind shoulders somewhat seriately arranged. Length, 2-2·5 mm.

Hab.—South Australia: Karoonda to Peebinga (G. E. H. Wright), Quorn (A. H. Elston), Lucindale (A. M. Lea).

From some directions there appears to be a distinct dark-velvety patch on the side near each shoulder, but this disappears when the side is viewed at a right angle. Although referred to C, *ff*, in the table, the seriate arrangement of the elytral punctures is rather faint.

Dryophilodes rufobrunneus, n. sp.

Dull reddish-brown; moderately clothed with short stramineous pubescence.

Eyes prominent and comparatively large. Antennae moderately long and thin. Prothorax at base very little wider than the median length; sides, as viewed from above, acute in middle and rather strongly arcuate to base, a vague oblique depression on each side of middle towards base; densely granulate-punctate. Elytra comparatively narrow, but distinctly wider than prothorax, parallel-sided to near apex; with closely placed series of asperate punctures to well beyond the middle, with crowded and small punctures all over. Length, 3-3·25 mm.

Hab.—South Australia: Lipson's Cove, under bark; New South Wales: Werris Creek (Rev. T. Blackburn).

From most points of view the prothorax and elytra appear to be closely covered with small granules. The Werris Creek specimen is slightly larger and darker than two from Lipson's Cove, but otherwise is in close agreement with them.

Dryophilodes seriatus, n. sp. Figs. 6, 7.

Dull reddish-brown; abdomen and legs somewhat paler; with very short pale pubescence.

Eyes small and prominent. Antennae not very long, several of the joints very little longer than wide. Prothorax at base not much wider than the median length; sides, as viewed from above, acutely produced in middle and arcuate to base, a shallow oblique depression on each side of middle near base; densely granulate-punctate. Elytra rather thin, much wider than base of prothorax, parallel-sided to near apex; with close-set rows of subquadrate punctures, becoming smaller posteriorly but traceable almost to apex; interstices with small punctures. Length, 3 mm.

Hab.—Tasmania: Hobart (A. M. Lea).

In general appearance rather close to the preceding species, but slightly narrower, elytra with seriate punctures less asperate, traceable close to the apex itself, and the interstices with minute punctures, nowhere causing them to appear granulate. From some directions the hind angles of the prothorax appear to be more than 90 degs., but from a perpendicular point of view they are seen to be less.

Dryophilodes flavipalpis, n. sp.

Dull castaneous-brown; abdomen and legs paler, palpi flavous. Rather densely clothed with short pale pubescence, denser on hind angles of prothorax than elsewhere.

Eyes small and prominent. Antennae not very long, some of the joints scarcely, if at all, longer than wide. Prothorax at base not much wider than the median length, sides strongly rounded in middle and arcuate to base, hind angles acute and slightly overlapping elytra; punctures crowded but partially concealed. Elytra not much wider than widest part of prothorax, parallel-sided to near apex; with dense and minute punctures, and fairly distinct rows of larger ones, disappearing posteriorly. Length, 2·5-3 mm.

Hab.—South Australia: Murray Bridge (Rev. T. Blackburn), Barossa (A. H. Elston), Ooldea (A. M. Lea); Western Australia: Swan River (Lea).

The seriate punctures on the elytra are distinct from most directions, they are rather stronger towards the sides than suture.

Dryophilodes interstitialis, n. sp.

Colour and clothing as described in preceding species.

Head as in preceding species. Prothorax moderately transverse, sides angulate but not apparently spinose in middle, somewhat arcuate to base, hind angles acute; punctures crowded and with a granulated appearance. Elytra not much wider than widest part of prothorax; with close-set rows of rather large asperate punctures, the rows disappearing posteriorly, the surface generally with a distinctly granulated appearance. Length, 2·25-2·5 mm.

Hab.—Western Australia: Mount Barker (R. Helms), Swan River (A. M. Lea).

In general appearance decidedly close to the preceding species, but slightly more robust, and seriate punctures of elytra somewhat larger and more asperate, and the interstices between them with a distinctly granulated appearance, that is wanting in that species.

Dryophilodes pulverulentus, n. sp.

Dull castaneous-brown; abdomen, legs, and hind parts of elytra somewhat paler, palpi flavous. Clothed with extremely short pubescence, almost dust-like on the elytra.

Eyes of moderate size and very prominent. Antennae moderately long, most of the joints scarcely or not at all longer than wide. Prothorax with outlines as in preceding species, but with somewhat smaller punctures. Elytra with

outlines as in preceding species, but punctures and interstices as on *D. flavipalpis*. Length, 2·25-2·75 mm.

Hab.—South Australia: Tumby Bay (Rev. T. Blackburn), Lucindale (A. M. Lea); New South Wales: Queanbeyan (Lea).

Structurally and in general appearance very close to the two preceding species, but the characters noted in the table are sufficiently distinctive when specimens of each are placed side by side. The general outlines are nearer those of *D. interstitialis*, than those of *D. flavipalpis*, but the elytral punctures of *D. interstitialis* are decidedly coarser than on either of the others.

Dryophilodes melanostethus, n. sp.

Dull reddish-castaneous; metasternum black. Rather densely clothed with short pale pubescence, denser on hind angles of prothorax and on scutellum than elsewhere.

Eyes rather small and very prominent. Antennae not very long, second to fourth joints scarcely longer than wide. Prothorax moderately transverse, sides not very strongly rounded in middle and somewhat arcuate to base, hind angles acute; punctures crowded and (except at apex) slightly larger than on head. Elytra at base scarcely wider than widest part of prothorax, sides not quite parallel to near apex; with close-set rows of fairly large asperate punctures, becoming smaller posteriorly, surface generally with small punctures, but between the rows with a granulated appearance. Length, 2-3 mm.

Hab.—South Australia: Adelaide (J. G. O. Tepper), Quorn (A. H. Elston), Murray Bridge (A. M. Lea); New South Wales: Sydney, reared from coccid galls (W. W. Froggatt), Tamworth (Lea).

In general appearance close to *D. metasternalis*, but elytra with distinct series of punctures. The basal segment of the abdomen is usually black, and occasionally the whole abdomen is dark, although hardly as black as the metasternum. Two of the South Australian specimens are decidedly below the average size, and have a suggestion of the subhumeral velvety patches of *D. subhumeralis*, from which they are at once distinguished by the sides of the prothorax. The pubescence on the hind parts of the elytra, of the South Australian specimens, in some lights, has a distinct golden-red gloss. The New South Wales specimens have a darker and duller appearance than the others, and their pubescence is slightly longer and denser, but otherwise they agree well with typical ones.

Dryophilodes subcylindricus, n. sp.

Black, palpi and parts of legs reddish. Pubescence extremely short, pale, and depressed.

Eyes small and prominent. Antennae rather long and thin, second and third joints smaller than the others. Prothorax about one-fourth wider than long, strongly and evenly convex, except for a slight medio-basal elevation, sides strongly and evenly rounded, hind angles obtuse; punctures as on head. Elytra parallel-sided to near apex, slightly narrower than widest part of prothorax; with crowded and small, non-seriate punctures. Length, 2-2·5 mm.

Hab.—South Australia: Mount Lofty Ranges, Myponga, Barossa (A. H. Elston), Karoonda to Peebinga (G. E. H. Wright), Parachilna (E. L. Savage), Lucindale (B. A. Feuerheerdt), Port Lincoln (Rev. T. Blackburn and A. M. Lea), Gawler (Lea); Tasmania: Huon River, Mount Wellington, Hobart (Lea).

A narrow, subcylindrical, black species, appearing greyish on account of its minute pubescence. The tarsi and usually the tibiae are reddish, but the latter are sometimes almost as dark as the femora; the antennae are usually blackish, but are occasionally obscurely reddish, rarely the abdomen is obscurely diluted

with red. The antennae vary somewhat in length, and the median joints of the male are stouter than those of the female. Three specimens, from Quorn (A. H. Elston), probably belong to this species, but have the apical half of elytra and the antennae obscurely reddish, and the tibiae and tarsi of a brighter red than usual.

Should it be eventually decided to split up the genus this species and *D. vigilans*, *D. angustus*, and *D. minor* should be associated together, although now separated by the exigencies of the table.

var. **brunneus**, n. var.

Nine specimens from South Australia—Myponga and Quorn (A. H. Elston), Lucindale (B. A. Feuerheerdt), Oodnadatta (Rev. T. Blackburn), and Mount Gambier (A. M. Lea)—appear to belong to this species, but differ from the others in being of a more or less dingy brown, with the sterna (and on two specimens the head) black.

Dryophilodes fumosus, n sp.

Dull dark brown, sterna darker. Closely covered with short ashen pubescence, appearing almost white on scutellum.

Eyes not very large but very prominent. Antennae moderately long and thin. Prothorax moderately transverse, sides strongly rounded in middle, where the width is slightly more than that of elytra, hind angles slightly more than right angles; punctures much as on head. Elytra parallel-sided to near apex; with crowded and small punctures, but towards base and sides with obscure series of larger ones. Length, 3 mm.

Hab.—Northern Queensland (Blackburn's collection).

A subcylindrical, dingy-brown species; although distinct from all other species before me, its position in the table is somewhat doubtful, as, from some directions, a lineate arrangement of punctures is traceable towards the base of elytra, and it is rather narrower than the other species referred to *yy*.

Dryophilodes robustus, n. sp.

Dull reddish-brown; sterna almost black. Densely clothed with more or less golden pubescence, becoming whitish on under surface and on scutellum.

Eyes small and prominent. Antennae moderately long and thin. Prothorax not much wider than long, sides strongly rounded in middle and somewhat arcuate to base, hind angles slightly more than 90 degs., punctures larger than on head. Elytra slightly wider than prothorax, not thrice as long as wide, parallel-sided to near apex; with small crowded punctures. Length, 2·75-3·25 mm.

Hab.—South Australia (A. H. Elston), Parachilna (E. L. Savage); New South Wales: Gosford (A. M. Lea).

A rather robust species, with elytral pubescence from some directions appearing of a beautiful golden-red; the pubescence at the base of the prothorax is scarcely as white as on the scutellum, although it is paler than on the rest of the upper surface. The punctures of the upper surface are usually concealed by the clothing, but where this has been abraded they are seen to be more sharply defined than is usual in the genus.

Dryophilodes niger, n. sp.

Black; legs and muzzle reddish, apical slope of elytra and tip of abdomen obscurely reddish. With short, depressed, whitish pubescence, denser on scutellum and on hind angles of prothorax than elsewhere.

Eyes small and very prominent. Antennae moderately long. Prothorax about once and one-half as wide as long, sides strongly rounded, hind angles obtuse; punctures somewhat larger than on head. Elytra rather robust, the width of base of prothorax, parallel-sided to near apex; with crowded punctures, nowhere seriate in arrangement, but larger towards base than posteriorly Length, 2-2·25 mm.

Hab.—South Australia: Ooldea (A. M. Lea).

A short black species, with somewhat silvery clothing On the type the legs are distinctly reddish, on a second specimen they are almost black; the antennae of both specimens appear to be black, but on close examination some of the joints are seen to be obscurely brownish. From some directions the upper surface appears to be granulate, rather than punctate; this is especially noticeable on the sides of the prothorax.

Dryophilodes pullatus, n. sp.

Black; apex of elytra, abdomen, antennae, palpi, and parts of legs more or less obscurely reddish. Rather densely clothed with dingy ashen pubescence, having a rather loose appearance on upper surface.

Eyes rather small and very prominent. Antennae rather thin Prothorax moderately transverse, sides strongly rounded, hind angles apparently rounded off; punctures crowded and slightly larger than on head. Elytra the width of widest part of prothorax, parallel-sided to near apex; with rather dense punctures, becoming smaller posteriorly. Length, 3·5 mm.

Hab.—Tasmania: Kelso (Aug. Simson).

A black subcylindrical species, in general appearance strikingly close to several species of *Dasytes*, of the Malacodermidae. The hind angles of the prothorax are small, but from most directions they appear to be completely rounded off; the elytral punctures are larger and sparser on the sides near the shoulders than elsewhere, and from some directions they appear to be lineate in arrangement, but from above the lineate arrangement is nowhere evident. The metasternum is more shining than is usual in the genus.

Dryophilodes albatus, n. sp.

Dull reddish-brown; palpi and abdomen usually paler. Densely clothed with white pubescence.

Eyes small and prominent. Antennae moderately long. Prothorax moderately transverse, sides somewhat rounded in middle and oblique to base, hind angles slightly overlapping elytra and slightly more than 90 degs.; punctures crowded and normally concealed. Elytra slightly wider than prothorax, parallel-sided to near apex; with crowded punctures, the basal half or two-thirds in addition with series of larger ones. Length, 2·75-3·25 mm.

Hab.—South Australia: Myponga (A. H. Elston), Kangaroo Island (J. G. O. Tepper), Lucindale (B. A. Feuerheerdt), Mount Gambier (A. M. Lea); Victoria: Cheltenham, in November (F. E. Wilson); Tasmania: Kelso, Karoola, Georgetown, Beaconsfield (Aug. Simson), Huon River, Ulverstone, Hobart (Lea), Strahan (H. J. Carter and Lea); New South Wales: National Park, Sydney (Lea).

Some of the specimens are darker than usual (almost piceous-brown), but the pubescence appears to be always whitish. There are seriate punctures on at least the basal half of elytra, but it is usually necessary to partly abrade the pubescence to be sure of this.

Dryophilodes multiseriatus, n. sp.

Black; elytra, palpi, legs, and basal half of antennae of a more or less dingy brown; with short, pale, inconspicuous pubescence.

Eyes rather large and very prominent. Antennae comparatively short. Prothorax moderately transverse; sides, as viewed from above, subacutely produced in middle, hind angles obtuse, each side of middle with two shallow impressions, an oblique one and a transverse one, meeting in middle of base; punctures slightly larger than on head. Elytra wider than prothorax, parallel-sided to near apex; with close-set rows of fairly large punctures, terminated just before the apical slope, on which all the punctures are minute. Length, 2-2·5 mm.

Hab.—South Australia: Port Lincoln (Rev. T. Blackburn), Ooldea (A. M. Lea).

The impressions on the pronotum and the seriate punctures on the elytra are more conspicuous than usual. One specimen, probably immature, is of a dingy brown, with the elytra and legs almost flavous.

Dryophilodes latipennis, n. sp.

Black; elytra, antennae, and legs of a dingy reddish-brown, palpi paler. Moderately clothed with short ashen pubescence.

Eyes small and prominent. Antennae rather short, only the first and eleventh joints distinctly longer than wide. Prothorax distinctly transverse, sides moderately rounded, hind angles more than 90 degs., median line fairly distinct; punctures slightly larger than on head. Elytra slightly wider than prothorax, scarcely twice as long as wide, sides almost parallel to near apex; with crowded and small punctures, and, in addition, with rather inconspicuous series of larger ones on basal two-thirds. Length, 2·5-3·75 mm.

Hab.—Western Australia: Swan River, Darling Ranges, Bridgetown (A. M. Lea).

With the robust form of *D. latus*, but elytral pubescence uniform throughout, although sometimes denser on scutellum and on hind angles of prothorax than elsewhere. The front edge of the prothorax is usually obscurely reddish.

Dryophilodes brevicornis, n. sp.

Black; elytra, abdomen, antennae, and legs of a more or less dingy reddish-brown, palpi paler. Moderately clothed with short ashen pubescence.

Eyes small and prominent. Antennae rather short, most of the joints wider than long. Prothorax moderately transverse; sides, as viewed from above, somewhat acutely produced in middle, hind angles more than 90 degs.; punctures slightly larger than on head. Elytra slightly wider than widest part of prothorax, parallel-sided to near apex; with small crowded punctures, the basal two-thirds with inconspicuous rows of larger ones. Length, 2·5 mm.

Hab.—South Australia: Port Lincoln (A. M. Lea).

At first sight very near *D. brunneipennis*, but antennae somewhat shorter and prothorax more convex in middle, with its hind angles more than 90 degs.

Dryophilodes marginicollis, n. sp. Figs. 8, 9.

Dull dark brown; abdomen and palpi paler. Clothed with short ashen pubescence.

Eyes of moderate size and very prominent. Antennae not very long. Prothorax moderately transverse, strongly convex, sides distinctly margined from base to apex; densely granulate-punctate. Elytra slightly wider than prothorax, parallel-sided to near apex; with crowded and small punctures, and in addition with larger seriate ones, distinct above base and shoulders, but vanishing on apical third. Length, 3 mm.

Hab.—North-western Australia: Fortescue River (W. D. Dodd).

The prothoracic margins are somewhat as in *D. serricornis*, but the antennae are normal. From some directions the hind angles of the prothorax appear to be acute, but from others to be obtuse or even rounded off. On the type the elytra are somewhat paler on the apical slope than elsewhere, and each side near the shoulder, from some directions, appears to have a dark velvety patch, but this disappears when viewed at a right angle.

Dryophilodes ubiquitosus, n. sp.

Dull dark brown; abdomen and palpi paler. Densely clothed with rather short ashen pubescence, denser and paler on scutellum, and on hind angles of prothorax than elsewhere.

Eyes fairly large and very prominent. Antennae not very long. Prothorax about once and two-thirds as wide as long; sides, as viewed from above, subacutely produced in middle, hind angles obtuse, median line faintly impressed in front; punctures slightly larger than on head. Elytra scarcely wider than widest part of prothorax, parallel-sided to near apex; with crowded and small punctures, and close-set series of larger ones, distinct on basal half but vanishing posteriorly. Length, 2·5-3 mm.

Hab.—South Australia: Adelaide, Barossa (A. H. Elston), Mount Lofty (S. H. Curnow), Lucindale (B. A. Feuerheerdt and F. Secker), Tumby Bay (Rev. T. Blackburn), Kangaroo Island (J. G. O. Tepper and A. M. Lea); Victoria: Alps (Blackburn), Birchip (J. C. Goudie); New South Wales (Blackburn), Forest Reefs, Galston, Sydney (Lea); Northern Queensland (Blackburn's collection).

A fairly robust, dingy species; one of the specimens from New South Wales is almost black. The clothing on the hind angles of the prothorax is not perhaps actually paler than elsewhere, but from most directions it appears to be so, probably from its greater density.

Dryophilodes obscuripennis, n. sp.

Black; antennae, palpi, and legs (the femora sometimes excepted) of a dingy reddish, elytra obscurely diluted with red posteriorly. Moderately clothed with dingy ashen pubescence.

Eyes rather small and very prominent. Antennae moderately long. Prothorax almost twice as wide as long; sides, as viewed from above, evenly rounded in middle, hind angles slightly more than 90 degs., median line faintly traceable from base to apex; punctures much as on head. Elytra slightly wider than prothorax, parallel-sided to near apex; with dense and small punctures, in addition with close-set series of fairly large ones, well defined on basal third, but vanishing before apical slope. Length, 2·25-3 mm.

Hab.—New South Wales: Galston (D. Dumbrell and A. M. Lea).

A rather robust species, structurally close to *D. latipennis*. The base of the elytra appears to be always as dark as the prothorax, but the hind parts are more or less obscurely paler; from some directions the derm about the shoulders appears to be covered with small granules.

Dryophilodes abjectus, n. sp.

Dull castaneous-brown; with short pale pubescence.

Eyes rather small and prominent. Antennae fairly long and rather thin. Prothorax about once and two-thirds as wide as long; sides, as viewed from above, rather sharply angulate in middle, hind angles more than 90 degs.; closely granulate-punctate. Elytra scarcely wider than widest part of prothorax, parallel-sided to near apex; with crowded and small punctures, about base with

series of larger ones, but the series scarcely traceable to middle, except on sides. Length, 1·75 mm.

Hab.—South Australia: Port Lincoln (Rev. T. Blackburn).

A small dingy species. The palpi and legs are paler than the other parts but not very conspicuously so.

A specimen from Tasmania (Karoola, Aug. Simson) possibly belongs to this species, but its prothorax is less transverse, and the elytral punctures are larger and more asperate, with the lineate arrangement of the larger ones traceable almost to the apical slope.

Dryophilodes subapicalis, n. sp.

Dull, dark castaneous-brown; with short, depressed, pale pubescence

Eyes of moderate size and very prominent. Antennae rather long and thin, all the joints, except the second, longer than wide. Prothorax strongly transverse, sides strongly rounded, hind angles obtuse; punctures crowded and small. Elytra elongate, scarcely wider than widest part of prothorax, parallel-sided to near apex; densely granulate-punctate, in addition with close-set rows of asperate punctures, distinct to well beyond the middle, and on the sides almost to apex Length, 3·75-4·5 mm.

Hab.—Western Australia: Swan River (A. M. Lea)

A comparatively large subcylindrical species. On the apical slope of elytra there appears to be a large and fairly distinct reddish spot, narrowly traversed by the dark suture; the suture, in fact, is very narrowly blackish throughout, but is only conspicuously so where it traverses the paler portion; on the larger of two specimens the abdomen is somewhat paler than the metasternum From some directions the pubescence on the upper surface has a reddish gloss. The hind angles of the prothorax are about 120 degs., but from some directions they appear to be rounded off. From most points of view the elytral interstices appear to be distinctly granulate rather than punctate, whilst the shoulders and about the base seem roughly granulate.

Dryophilodes vigilans, n. sp.

Black, some parts opaque; palpi, tibiae, and tarsi reddish; with extremely short, dingy, depressed pubescence.

Eyes rather large and very prominent. Antennae rather long and thin, median joints stouter, second smallest. Prothorax moderately transverse, sides strongly and evenly rounded; punctures as on head. Elytra long, thin and parallel-sided, slightly narrower than widest part of prothorax; with dense and minute punctures, and with series of larger ones, fairly distinct on the basal half, but vanishing posteriorly. Length, 2·5-3·25 mm.

Hab.—New South Wales: Forest Reefs (A. M. Lea).

A thin black species, structurally close to *D. subcylindricus*, but consistently larger, eyes larger and elytral punctures seriate in arrangement on the basal half, although the arrangement is indistinct from most directions. In the male the tip of the abdomen is slightly notched, and the eyes are larger than in the female. The antennae are usually of a dingy reddish-brown, with the basal joint darker, the tips of the abdominal segments are usually reddish, occasionally the entire abdomen is obscurely diluted with red. The median base of the pronotum, although not elevated above the front parts, is slightly elevated above the adjacent surface. Four specimens have the prothorax and elytra obscurely brownish, but are probably immature. A specimen from Mount Kosciusko (W. E. Raymond) probably belongs to the species, but has the elytra of a dark reddish-brown, except that a large subtriangular space about the scutellum, and the shoulders, are black.

Dryophilodes planicollis, n. sp.

Black; elytra, antennae, palpi, and legs (except femora) more or less reddish, abdomen obscurely reddish posteriorly. Clothed with ashen pubescence, with a rather loose appearance.

Eyes small and very prominent. Antennae rather long and thin, all the joints, except the second, longer than wide. Prothorax rather flat, not much wider than long, sides strongly rounded and very finely serrated, hind angles obtuse, median line faintly marked; punctures slightly larger than on head. Elytra rather thin, scarcely wider than widest part of prothorax, but conspicuously wider than its base, parallel-sided to near apex; with fairly dense punctures about base, but becoming comparatively sparse posteriorly. Length, 2·25 mm.

Hab.—Western Australia: Swan River (A. M. Lea).

The prothorax is flatter than usual, practically only the front sides sloping downwards, its hind angles also are almost rounded off, the minute serrations of the sides are somewhat obscured by the clothing. The elytral punctures are rather sharply defined, but are comparatively sparse posteriorly, and their lineate arrangement is feeble, even near the base.

Dryophilodes nigrinus, n. sp.

Black, some parts paler. Rather sparsely clothed with ashen pubescence.

Eyes of moderate size and very prominent. Antennae not very long, only the first and eleventh joints distinctly longer than wide. Prothorax moderately transverse, sides strongly rounded, the greatest width equal to that of elytra, hind angles obtuse; punctures small and crowded. Elytra rather thin, parallel-sided to near apex; with close-set rows of fairly large punctures, becoming smaller posteriorly, but distinct almost to apical slope. Length, 2-2·5 mm.

Hab.—South Australia: Port Lincoln (Rev T. Blackburn), Mount Lofty (N. B. Tindale).

In general appearance much like *D. planicollis*, but the seriate arrangement of the elytral punctures is distinct to well beyond the middle. Five specimens are before me; of these four have the elytra black, with the hind parts more or less obscurely diluted with red, the other has the elytra of a dingy brown throughout; the antennae and legs are blackish, except that the tarsi are obscurely reddish; even the palpi are dark. The prothorax has several very vague discal impressions, and usually a shining but feeble median elevation near the base; the hind angles from some directions appear to be rounded off, from others each appears as a minute tooth. One specimen is distinctly wider than the others, but may represent a variety.

Dryophilodes politus, n. sp.

Black; apical parts of elytra and parts of legs, of antennae, and palpi more or less reddish. With sparse ashen pubescence.

Eyes rather small and very prominent. Antennae thin but not very wide. Prothorax scarcely wider than long, sides subacutely produced in middle, hind angles obtuse; punctures crowded and somewhat coarser than on head, but becoming very small on a shining space at middle of apex, and on a shining median line, the latter abruptly terminated near base. Elytra shining, conspicuously wider than widest part of prothorax, and much wider than its base, parallel-sided to near apex; with close-set rows of fairly large punctures, disappearing posteriorly, where the surface is minutely punctate. Length, 1·75-2 mm.

Hab.—South Australia: Mount Lofty (S. H. Curnow); Western Australia: Swan River (A. M. Lea).

This species has the general appearance as of the New Zealand genus *Sphinditeles (Mesanobium* of Sharp), and it may be desirable eventually to refer it to that genus. On the type the apical slope of elytra (except that the suture is very narrowly dark) is of a rather bright reddish-flavous; on the Swan River specimen the apical slope is but obscurely diluted with red, on each of them the apical half of the antennae is blackish. Owing to the sparsity of pubescence the punctures are more sharply defined than usual.

Dryophilodes subopacus, n. sp.

Black, subopaque; tarsi, knees, and coxae reddish, apical slope of elytra obscurely diluted with red. Moderately clothed with short ashen pubescence.

Eyes fairly large and very prominent. Antennae moderately long, but only the first and eleventh joints distinctly longer than wide. Prothorax not much wider than long, sides strongly rounded in middle (from some directions appearing subacute there); median line somewhat shining and fairly distinct near base; punctures crowded and small. Elytra wider than widest part of prothorax, and much wider than its base, parallel-sided to near apex; with crowded and small punctures or finely shagreened, in addition with close-set rows of fairly large asperate punctures, distinct to well beyond the middle, and on the sides almost to apex. Length, 2 mm.

Hab.—New South Wales: National Park (A. M. Lea).

A narrow dingy species, but with parts of the under surface shining; the elytra at first appear to be as black as the prothorax, but when closely examined are seen to be obscurely paler. Partly owing to the clothing most parts of the upper surface appear to be minutely granulate. Structurally it is rather close to the preceding species, but is duller, more densely clothed, and the prothorax and eyes are larger.

Dryophilodes minor, n. sp.

Piceous or blackish, legs and abdomen more or less reddish. Rather densely clothed with pale pubescence, having a rather loose appearance.

Head with crowded, partially concealed, punctures. Eyes small and very prominent. Antennae rather long and thin. Prothorax moderately transverse, sides strongly rounded and slightly wider than elytra, hind angles obtuse; with small crowded punctures. Elytra rather thin, parallel-sided to near apex; with crowded and small punctures, the basal half with obscure series of larger ones. Length, 1·75-2 mm.

Hab.—Tasmania: Huon River (A. M. Lea).

A small, narrow, dingy species, whose specimens have the general appearance as of females of *Cis.* The prothorax usually appears to be blackish, with the apex rather widely reddish, or sometimes with both base and apex reddish; on some specimens the derm of the elytra appears blackish, but it is usually of a dingy brown; the metasternum is usually darker than the abdomen, and the apical half of the antennae is darker than the basal half.

Dryophilodes cribripennis, n. sp. Figs. 10, 11.

Dull reddish-brown; abdomen and parts of legs somewhat paler. Moderately clothed with rather short pale pubescence, denser on scutellum and on hind angles of prothorax than elsewhere.

Eyes small and prominent. Antennae moderately long, most of the joints longer than wide. Prothorax moderately transverse, sides, as viewed obliquely from behind, apparently acutely produced at basal third, but oblique to base,

hind angles obtuse; median line faint but distinct from some directions; punctures crowded and slightly larger than on head. Elytra rather narrow but much wider than base of prothorax, parallel-sided to near apex; with dense and small but rather sharply defined punctures, and in addition with close-set rows of larger asperate ones, becoming smaller posteriorly, but distinct to summit of apical slope and on the sides to apex. Length, 2 mm.

Hab.—New South Wales: Gosford (A. M. Lea).

A small dingy species, with median line of prothorax traceable from base to apex from some directions, but invisible from others. As on many others of the genus, parts of the derm appear minutely granulate through the clothing.

Dryophilodes parvicollis, n. sp.

Dull reddish-brown; palpi paler. Moderately clothed with pale pubescence, denser on scutellum and on base of prothorax than elsewhere.

Eyes small but very prominent. Antennae rather long and thin. Prothorax not much wider than long, sides strongly rounded in middle, from some directions appearing angulate, hind angles obtuse; median line not traceable; punctures crowded and small, becoming minute at middle of apex. Elytra rather thin, conspicuously wider than widest part of prothorax; with crowded minute punctures, and in addition with close-set rows of fairly large ones, traceable to summit of apical slope, and on the sides to near apex. Length, 2-2·5 mm.

Hab.—Western Australia: Albany (Blackburn's collection and R. Helms), Geraldton (A. M. Lea); Queensland: Mount Tambourine (Lea).

In general appearance close to the preceding species, but prothorax smaller, sides, as viewed from behind, less acutely angulate, without a median line, antennae somewhat longer, and the small punctures of elytra less sharply defined. The Queensland specimen is slightly smaller, and has slightly larger eyes than the others, but there appears to be nothing to warrant its specific separation.

Dryophilodes pallidus, n. sp.

Pale castaneous, upper surface feebly shining, under surface brighter. Clothed with short pale pubescence.

Eyes small and prominent. Antennae rather long and thin. Prothorax moderately transverse, sides, as viewed from behind, rather acute in middle, hind angles slightly more than 90 degs.; punctures crowded and minute. Elytra rather thin, distinctly wider than widest part of prothorax, parallel-sided to near apex; with dense and minute punctures, and in addition with larger seriate ones, fairly distinct on basal third, but, except on sides, not traceable to middle. Length, 1·5 mm.

Hab.—Western Australia: Geraldton (A. M. Lea).

An unusually small pale species.

Ernobius mollis, Linn., Syst. Nat., x., 1758, p. 355.

This species can now be recorded as Australian, as specimens have been taken in New South Wales (Sydney) and Tasmania (Launceston). Seven synonyms and varieties are noted in Pic's recent catalogue of the family.

Lasioderma serricorne, Fab. Fig. 12.

Two specimens received from Mr. W. W. Froggatt are labelled as having been taken "in wax of wild bee" at Derby (North-western Australia); they are decidedly above the average size of the species, but I can find no other distinguishing feature.

Deroptilinus, n. gen.

Head concealed from above. Eyes small, round, entire, latero-frontal. Antennae inserted in front of eyes, and slightly inwards, basal joint rather large, second to fourth, sixth and eighth, more or less triangular, eleventh elongate, the others each with a long ramus. Prothorax finely margined throughout, front portion granulate. Scutellum moderately large. Elytra slightly narrowed posteriorly, not quite covering the abdomen. Prosternum reduced to a minimum in front, with concealed cavities for the reception of antennae. Mesosternum concealed, except for a very short intercoxal process Metasternum elongate, episterna wide. Abdomen with five distinct segments, the basal one deeply grooved on each side for the reception of hind legs. All legs capable of being received in depressions, the femora grooved for reception of tibiae, tarsi with four basal joints short, produced on lower surface, fifth about as long as two preceding ones combined.

Apparently nearer *Ptilinus* than any other genus, but prosternum different in front, elytra not completely covering the abdomen, two basal joints of tarsi much shorter and antennae different The intervention of small joints between the fifth, seventh, and ninth is alike on the four specimens before me, but the rami vary in length, probably with sex; on *Ptilinus* the antennae are strongly serrated in the female. The head when removed from the body is seen to have a narrow neck, with a ridge or fine groove along its middle

Deroptilinus granicollis, n. sp. Fig. 18.

Black; shoulders and tips of elytra and legs obscurely reddish, basal joints of antennae and tarsi paler. Densely clothed with very short ashen pubescence, somewhat variegated on elytra.

Head densely granulate-punctate or shagreened. Antennae with apical joint and rami of fifth, seventh, ninth, and tenth distinctly longer than first. Prothorax moderately transverse, front strongly rounded and about half the width of base; densely and finely granulate, but apical half, except on sides, more coarsely granulate. Elytra scarcely more than twice the length of prothorax; with rather feeble striae, becoming still more feeble posteriorly but rather deep on the sides near shoulders; interstices with dense and rather small asperate punctures, and much denser and very minute ones. Metasternum with dense asperate punctures, median line narrow and rather deep. Length, 3·75-4·25 mm.

Hab.—Tasmania (H. H. D. Griffith).

The rather coarse granules on the front of the prothorax are as in many species of *Bostrychidae* and *Scolytidae*. There are punctures in the elytral striae, but partly owing to the density of the general punctures, and partly to the pubescence, they are not sharply defined. The description is that of a male, a specimen that accompanied it, and is probably a female, has the elytra and abdomen of a dingy brown, the shoulders paler than the rest of the elytra, and its antennae with the rami of the fifth and tenth joints no longer than the first joint. A specimen from King Island has the extreme margins of elytra (but not the shoulders) paler than the adjacent parts; its antennae are as in the second specimen. One from northern Queensland has the elytra and femora scarcely paler than the adjoining parts; with the apical joint of antennae and the rami somewhat longer and darker than on the type. On the elytra of the type pale pubescence is conspicuous on the basal fourth, narrowly continued along the suture, and suddenly dilated to form a diamond-shaped patch about the summit of the apical slope, on the rest of the elytra the pubescence is brownish; on the second Tasmanian specimen the pale patches are traceable but less sharply defined; on the others the elytral clothing is almost uniformly brown.

Trypopitys multimaculatus, n. sp.

Castaneous-brown or piceous-brown; antennae, palpi, and tarsi paler. Densely clothed with ashen and whitish pubescence, conspicuously maculate or mottled on upper surface.

Head rather small, punctures crowded but normally concealed. Eyes rather small but prominent. Antennae rather short, first joint rather large, second small, third and fourth still smaller, fifth to tenth larger and somewhat serrated, eleventh slightly larger than tenth. Prothorax slightly wider than long, strongly gibbous along middle, sides strongly produced downwards; with crowded partially concealed punctures. Elytra thin, parallel-sided to near apex; with regular rows of large punctures, becoming smaller posteriorly, interstices feebly separately convex, with small and minute punctures. Pectoral canal deep, connected with a narrow, deep, median line on posterior two-thirds of metasternum Basal segment of abdomen about two-thirds the length of second, all with curved sutures. Legs thin and moderately long. Length, 4-6 mm.

Hab.—Tasmania (Aug. Simson), Launceston, Hobart; New South Wales: Forest Reefs (A. M. Lea).

The two shades of pubescence are irregularly intermingled on the pronotum, but on the elytra the paler kind forms numerous irregular spots, in places sometimes conjoined to form short oblique fasciae, the clothing on the scutellum is usually conspicuously whitish On some specimens the elytral punctures are considerably larger than on others, being decidedly wider than the interstices on the basal half; such specimens are usually smaller and darker than the others, and are probably males.

This and the two following species have a deep and conspicuous notch at the median front of the metasternum, continuing the pectoral canal as in *Anobium*, but the three apical joints of the antennae do not form a large loosely-compacted club, and the ninth and tenth are practically the same as the preceding joints, the eleventh being only a little longer; hence they have been referred to *Trypopitys*, now first recorded as Australian. On each of them, on each side of the prothorax, there is a rather acute ridge that is directed obliquely downwards and forwards, but terminates half-way from the apex; it is more or less obscured by the clothing and legs, and is invisible from above

Trypopitys pictipennis, n. sp.

Castaneous-brown; most of elytra darker, antennae and palpi paler. Densely clothed with pale brown, or somewhat ochreous pubescence, irregularly mottled with black on elytra; on under surface becoming greyish-white.

Head with crowded but mostly concealed punctures. Eyes large and prominent. Antennae with first joint rather large, second and third small, fourth to tenth strongly serrated, eleventh slightly longer than tenth and first. Prothorax slightly wider than long, strongly gibbous in middle, sides strongly produced downwards, an acute prominence in each hind angle; punctures rather coarse and partially concealed. Elytra thin and parallel-sided to near apex; with regular rows of large deep punctures, becoming smaller (but still large) posteriorly. Basal segment of abdomen about half the length of the following one, all with curved sutures. Length, 4·75 mm.

Hab.—New South Wales: Dorrigo (W. Heron).

Rather close to the preceding species, but more brightly coloured, pectoral canal longer, eyes decidedly larger, and antennae more conspicuously serrated; of the latter the fourth to tenth joints are all distinctly triangular, the fourth is wider than long, the intervening joints gradually altering to the tenth, which is longer than wide; the pectoral canal is continuous from apex of prosternum

to apex of metasternum, but about the middle of the latter it is traversed by a narrow shining ridge, behind which it rapidly narrows to its end. On the basal third of elytra the pubescence is mostly black, on the apical two-thirds it irregularly covers about half of the derm.

Trypopitys uniformis, n. sp.

Pale castaneous; antennae and palpi paler. Densely clothed with short, pale, depressed pubescence, interspersed with short sloping setae.

Head with crowded, partially concealed, punctures. Eyes prominent and of moderate size. Antennae with basal joint large, second and third small, fourth to tenth somewhat obtusely serrated, eleventh about once and one-half the length of tenth, and about the length of first, but distinctly thinner. Prothorax slightly wider than long, strongly gibbous in middle, irregularly depressed near base, sides strongly produced downwards; with crowded and rather small, partially concealed, punctures. Elytra thin and parallel-sided to near apex; with regular rows of rather large and deep punctures, becoming smaller posteriorly; interstices gently separately convex, but more strongly convex on sides; with crowded, small, and minute punctures. Abdomen large, basal segment as long as third and about one-third shorter than second, all with curved sutures. Legs thin but not very long. Length, 6 mm.

Hab.—Tasmania: Hobart (A. M. Lea).

In general appearance close to large specimens of *Anobium domesticum*, but with the antennae of *Trypopitys*. The uniformly coloured pubescence of the upper surface at once distinguishes from the two preceding species; the posterior end of the pectoral canal is also different, the canal is deep between the front and middle legs, but behind the latter it slopes at an angle of 45 degs., and is rather obscure on its sides, a narrow depression along its middle connects with a narrow, deep, median line on the apical half of the metasternum.

Tasmanobium, n. gen.

Head concealed from above. Eyes rather large, prominent, and with small facets. Antennae serrated, non-clavate. Prothorax transverse, pronotum separated from each side of prosternum by an acute ridge. Scutellum distinct. Elytra narrow, parallel-sided, striation regular. Prosternum with a wide shallow groove in front for partial reception of head; flanks large, each produced to a point in front; metasternum elongate, side pieces large. Abdomen large. Legs rather long and thin, front coxae projecting and in contact, middle ones almost in contact, hind ones separated by a narrow intercoxal process; femora moderately grooved for reception of tibiae; basal joint of tarsi about as long as three following combined.

The three specimens of this genus before me in general appearance are strikingly close to *Anobium domesticum* and *Trypopitys uniformis*, but the absence of a pectoral canal, and the front coxae in contact, exclude it from both *Anobium* and *Trypopitys;* from the latter genus it is also excluded by the acute marginal ridges of the prothorax, and from the former also by the serrated antennae. By the table of Lacordaire it would be associated with *Trypopitys*, but in his diagnosis of that genus, as also of *Anobium*, the under surface (except of the head) is not even mentioned. By Leconte and Horn's table of the subgroup Anobia it would be associated with *Sitodrepa*, but in that genus each antenna has a large three-jointed club. In my table it is associated with *Secretipes*, with which it has little in common.

Tasmanobium mimicum, n. sp.

Pale castaneous; antennae and palpi paler Moderately densely clothed with minute pale pubescence.

Head comparatively large; with dense minute punctures. Antennae with first joint moderately large, second small, third to tenth somewhat obtusely serrated, eleventh about once and one-half the length of tenth and first. Prothorax moderately transverse, rather strongly convex but not gibbous in middle, sides rather strongly rounded near base, which is twice the width of apex, a large and somewhat angular depression on each side of base, and a transverse one on each side of apex; punctures partially concealed but apparently larger than on head. Elytra thin, no wider than greatest width of prothorax; with rows of rather large punctures, becoming smaller posteriorly and larger on sides; interstices feebly convex and minutely punctate or shagreened. Metasternum with a narrow, deep, median line. Abdomen with basal segment in middle quite as long as second, the latter slightly longer than third or fifth, fourth slightly shorter than these, all with straight sutures. Length, 5-6 mm.

Hab.—Tasmania: Hobart, Strahan (A. M. Lea).

There is a longitudinal carina at the base of the head, but to see it clearly the head must be detached from the prothorax

Secretipes, n. gen.

Head entirely concealed from above, its under surface transversely impressed between eyes. Mandibles short and stout, when at rest touching middle coxae. Eyes moderately large, lateral, and rather coarsely faceted. Antennae moderately long, eleven-jointed, basal joint stout, apical one slightly longer and thinner than tenth, the others somewhat serrated. Palpi small, apical joint securiform. Prothorax strongly convex, sides triangularly produced downwards and immarginate. Scutellum semicircular. Elytra with striae confined to sides Prosternum and mesosternum very short and normally concealed; metasternum elongate, narrowly grooved along middle, middle of apex with two processes between hind coxae; side pieces narrow at base, subtriangular posteriorly. Abdomen with basal segment rather short but distinct from side to side, second as large as third and fourth combined, fifth about half as long again as fourth. Legs rather small, the front ones smallest of all, and normally entirely concealed, their coxae in contact; middle legs received in lateral cavities, their tarsi received in shallow grooves, which are continued behind a median process of the mesosternum; hind legs received in abdominal depressions, the coxae touching elytra, trochanters rather large.

This genus quite evidently belongs to the Xyletini, but appears to be excluded from *Xyletinus* itself, and from all other described genera of that group by the following characters in combination:—Front legs entirely concealed with head at rest; hind legs retractile into abdominal excavations; antennae serrated, the three apical joints neither greatly elongated nor clavate; elytral striae confined to sides. The species have the general appearance of those of *Deltocryptus*, the smaller ones of *Pronus*, and the more elongated ones of *Dorcatoma;* but all of these have a large three-jointed club. Owing to the intervention of the processes of the metasternum between the hind coxae the abdomen appears to be without an intercoxal process. Type of genus, *S. xanthorrhoeae*.

Secretipes xanthorrhoeae, n. sp. Figs. 19, 40.

Of a more or less dingy brown, parts of legs paler, antennae and palpi flavous. Densely clothed with minute pale pubescence.

Densely and minutely punctate all over. Elytra with two moderate striae on each side, curving around apex, but only one almost touching suture.

Metasternum with median line somewhat dilated in middle but shallow there. Length, 2·5-3·5 mm.

Hab.—South Australia: Parachilna (E. L. Savage), Port Lincoln, Adelaide (Rev. T. Blackburn), Mount Lofty Ranges, taken by means of sweep net (A. M. Lea), Kangaroo Island (J. G. Otto Tepper), Lucindale (B. A. Feuerheerdt); Western Australia: Swan River, Donnybrook (Lea).

Some specimens have the upper surface almost castaneous-brown, on others it is mostly piceous-brown or even blackish, but with the sides obscurely paler; the metasternum is sometimes darker than the abdomen. Although only two striae are fairly distinct on each side, a third is faintly indicated in parts. Most of the specimens were taken from the dry flowering stems of species of *Xanthorrhoea.*

Secretipes latericollis, n. sp.

Dark castaneous-brown or piceous-brown; antennae, palpi, and tarsi paler, metasternum usually slightly darker than abdomen. Densely clothed with minute pale pubescence.

With dense and minute punctures, but larger and more distinct on metasternum and flanks of prothorax than elsewhere. Length, 2·5-2·75 mm.

Hab.—Queensland: Dalby (Mrs. F. H. Hobler), Townsville; New South Wales: Tamworth, Forest Reefs (A. M. Lea).

In general appearance close to the preceding species, and with similar elytral striae, except that they are somewhat deeper, but metasternum and flanks of prothorax with decidedly coarser punctures, the antennae are thinner, the basal joint is smaller, and the second larger in proportion.

Seven specimens from northern Queensland (Blackburn's collection) probably belong to this species, but are somewhat smaller (2-2·25 mm.) and thinner, and another from Dalby is still smaller.

Aulacanobium, n. gen.

Head concealed from above, under surface deeply bisinuate for reception of antennae. Eyes moderately large and with rather large facets. Antennae with basal joint large, the following seven small, the three apical ones forming a large club, of which the first and second joints each have a long ramus (longer in male than in female). Prothorax transverse, sides triangularly produced downwards. Scutellum distinct. Elytra strongly striated. Prosternum with triangular vertical flanks. Mesosternum normally concealed. Metasternum with a deep median groove. Abdomen with five segments, but only the intercoxal process of the first visible Legs rather short and received in cavities, the front pair thinner than the others, with their coxae pressed backwards and touching.

Although the type of this genus was described by Olliff as a *Dorcotoma,* its antennae are very different from those of that genus, and are received in two deep sinuations on the under surface of the head (much as in *Lasioderma serricorne),* the front coxae are in contact (instead of widely separated), and there is no cavity in the breast behind them, so that instead of belonging to the Dorcatomides it really belongs to Xyletinides, and should be placed near *Lasioderma.*

Aulacanobium lanigerum, Oll. *(Dorcatoma).* Figs. 13, 14, 20.

The type of this genus was evidently described from a contracted specimen; it is some years since I examined it, but there are now before me specimens that were compared and agreed with it. The antennae were originally described as "reddish-testaceous," but this only applies to the parts normally visible; the club is composed of three black joints, of which the first and second each have a long ramus (longer in the male than in the female). There are nine striae on

each elytron, and they are much stronger than on any other described Australian species of the subfamily. Two specimens were marked as taken from a fungus by Mr. W. W. Froggatt.

Dicoelocephalus, n. gen.

Head concealed from above, base of under surface deeply bisinuate and hollowed for reception of antennae. Eyes small. Antennae eleven-jointed, basal joint large, three apical ones forming a large loosely-compacted club. Prothorax bisinuate at base. Scutellum distinct. Elytra closely applied to prothorax, striate-punctate, or seriate-punctate. Prosternum with triangular flanks, base conjointly excavated with mesosternum on each side, for reception of front and middle legs; middle normally concealed by head; with an inner channel on each side for reception of side of head. Mesosternum concealed, except for intercoxal process. Metasternum deeply grooved in middle. Abdomen with first segment entirely concealed by hind legs, except for a small intercoxal process, the three following segments large, with their sutures bisinuate, the apical one longer. Legs received into excavations; front coxae pressed backwards, their tips in contact, middle coxae widely separated, the hind ones less widely separated but extending to the sides of abdomen, hind femora partly received in coxal grooves, each knee received in a notch on the side of an elytron, tibiae received in femora; tarsi short, hind and middle ones each received in a narrow groove near the trochanter.

With the head at rest the mandibles are in contact with the middle coxae, entirely concealing the front ones, so that, except for the more conspicuous rows of elytral punctures, there is nothing to distinguish the species from *Dorcatoma;* but on removing the head the front coxae are seen to be in contact, and there is no sternal cavity for the reception of the antennae, these being received in deep sinuations on the under surface of the head, much as on *Lasioderma serricorne.* From above the hind angles of the prothorax appear to be acute and to embrace the sides of elytra, but from the sides they are seen to be rounded off and to be more than right angles. The genus occurs also in New Zealand, as Mr. A. E. Brookes has an unnamed species of it from Okauia. Type of genus, *D. granipennis.*

Dicoelocephalus granipennis, n. sp. Figs. 21, 41.

Black, subopaque; parts of under surface and of legs obscurely paler; antennae reddish; with very short depressed, pale pubescence.

Head with dense [illegible] thin curved carina from near each eye to clypeal suture, [illegible], a feeble median carina at base. Antennae with basal j[illegible] but longer than wide, third somewhat smaller, fourth to eighth transverse, first and second joints of club large, subequal, wider and shorter than apical joint. Prothorax twice as wide at base as at apex, sides finely margined; with small crowded punctures. Elytra with small punctures in shallow striae, both becoming deeper on sides, interstices with dense and minute granules, denser on shoulders than elsewhere. Metasternum with moderately large punctures, median line closed at mesosternum, but open posteriorly. Apical segment of abdomen twice as long as the subapical one. Length, 4·5-5·25 mm.

Hab.—Western Australia: King George's Sound (G. Masters), Donnybrook (A. M. Lea).

An oblong-elliptic, strongly convex species, the pale pubescence on the black background gives the upper surface a mouse-coloured appearance; in parts it is somewhat wavy. The head and prothorax from some directions appear densely and finely granulate, but on the upper surface the only true granules are on the elytra, there they are very small, but being somewhat shining they are very

distinct in certain lights. On several specimens a faint median line may be traced on the prothorax. From the side the notch on each elytron for the hind knee is very distinct, the notch for the middle knee is larger but less abrupt.

Dicoelocephalus decipiens, n. sp.

Of a dark dingy brown and somewhat shining; under surface of head and antennae, except basal joint, paler; with rather dense, depressed, ashen pubescence.

Head with dense and small but sharply defined punctures. Antennae with basal joint and three joints of club large, the intervening joints small Prothorax with dense and small punctures Elytra parallel-sided to near apex; densely and finely punctate or shagreened, striation distinct on sides, but somewhat obscure elsewhere. Prosternum with triangular flanks exposed; metasternum apparently divided into two median parts by the tarsal grooves of the middle legs, with a deep and rather wide median line, in parts densely punctate and opaque, elsewhere shining. Abdomen apparently composed of four segments, owing to the true basal one being concealed by the hind legs, except for a small intercoxal process Length, 2·25 mm.

Hab.—New South Wales: Galston (A. M. Lea).

An oblong-elliptic species, much smaller than the preceding or the following ones but with the under surface of head deeply bisinuate, the lateral triangles of prosternum exposed and with similar abdomen and front legs. The middle parts of the sterna are evidently as in the following species, but the type being unique I have not dissected out the front and middle legs to examine the concealed parts. The elytral striae are traceable at regular intervals from suture to sides, but they appear as feeble undulations of a shagreened surface rather than defined lines containing distinct punctures; on the basal half of each side, however, there are three rather well-defined rows of rather large rugose punctures, the outer row beyond the middle appears more as a simple stria, and curves around the apex almost to touch the suture.

DICOELOCEPHALUS OBSCURUS, Macl. (*Cryptorhopalum*). Fig. 22.

This species was referred to *Cryptorhopalum*, of the Dermestidae, with expressed doubts; it certainly belongs to the Anobiides, and probably to *Dicoelocephalus*, with the type species of which it agrees in all essential generic features, notably in the bisinuate under surface of head, in the antennae, and the abdomen. Some specimens before me were compared and agreed with the type, although they were not then dissected. It is considerably smaller than *D. granipennis*, somewhat narrower, seriate punctures of elytra less conspicuous, without granules, and metasternum different. When the sternae are clearly visible the middle of the mesosternum appears to be fairly long (about half the length of the metasternum) and rapidly narrowed to disappear between the front and middle legs, its hind margin being defined by the tarsal grooves, but this appearance is deceptive, as the part really belongs to the metasternum; when the head is removed the mesosternum is exposed, and its middle appears as a small process scarcely larger than the second joint of antennae. The rows of punctures on the sutural two-thirds of elytra are rather faint, but appear more distinct owing to the pubescence; on the sides they are distinct on the basal half, but posteriorly become faint, except that the outer row is curved around the apex so as almost to touch the suture.

Hab.—Queensland: Gayndah (type), Dalby, Cairns; New South Wales: Illawarra, Forest Reefs.

Deltocryptus, n. gen.

Pronotum with sides produced downwards; prosternum normally entirely concealed, in the middle by the head, at the sides by the legs. Abdomen with basal segment concealed at sides by the legs, but with a fairly large triangular intercoxal process; sutures of the three following segments incurved to middle. Other characters as described in *Dicoelocephalus*.

This genus is certainly close to *Dicoelocephalus*, agreeing with it in the under surface of the head, antennae, concealed parts of legs, etc., but on that genus the pronotum is defined from the prosternum by an acute dividing line, between which and the front legs there is a well-defined triangle on each side; on the present genus the sides of the pronotum are brought downwards so that the dividing line between it and each side of the prosternum is in contact with the front legs, the triangle on each side being absent or rather entirely concealed; seen from each side there appears to be a triangular extension of the pronotum interposed between the front leg and eye for some distance, but for these to be in partial contact; on *Dicoelocephalus* the eye touches the exposed triangle of the prosternum, which completely separates it from the legs. Most of the species have the general appearance as of belonging to *Dorcatoma*, and unset specimens cannot readily be distinguished from that genus, but on detaching the head its under surface may be seen to be deeply bisinuate for the reception of the antennae (the head of at least one specimen of every species here described has been examined to make sure of this) and that the front coxae are in contact. Type of genus, *D. punctiventris*.

TABLE OF SPECIES OF DELTOCRYPTUS.

A. Abdomen with long pubescence partly obscuring its sutures .. .. *ursus*
AA. Abdomen with sutures well defined.
  B. Sutural half of elytra without distinct rows of punctures.
    a. Under surface pale .. .. *inamoenus*
    aa. Metasternum black . .. . *funereus*
  BB. Sutural half of elytra with rows of large, or at least distinct punctures.
    C. Pubescence extremely short and inconspicuous . .. .. *xyleboroides*
    CC. Pubescence mixed with longer hairs.
      D. Median line of metasternum wide .. .. *aulacostethus*
      DD. Median line of metasternum narrow in middle.
        E. Length, 2 mm. or more .. .. *punctiventris*
        EE. Length, 1½ mm. or less .. .. *microscopicus*

NOTE ON TABLE.

The longer hairs are usually inconspicuous, especially on *D. aulacostethus*, unless the insect is viewed from the sides; but on *D. xyleboroides* the pubescence itself is so short as to be almost dust-like.

Deltocryptus punctiventris, n. sp. Figs. 15, 23, 42.

Dark brown and slightly shining; under parts of head and antennae paler. Rather densely clothed with pale depressed pubescence, interspersed with numerous suberect hairs or setae.

Head with dense and small punctures. Antennae with basal joint and three joints of club large. Prothorax with punctures much as on head. Elytra with crowded and small punctures, and with regular rows of larger ones, becoming small posteriorly, the sides with rows of larger subquadrate punctures, the outer one curving around apex so as almost to touch the suture. Metasternum with crowded but sharply defined punctures, median line narrow and deep. Abdomen with dense punctures; basal segment distinct in middle and very narrowly traceable to sides. Length, 2-2·5 mm.

Hab.—Tasmania: Hobart (H H. D. Griffith and A. M. Lea), Waratah, in moss (H. J. Carter and Lea), Launceston (Aug. Simson); Victoria: Dividing Range (Rev. T. Blackburn); New South Wales: National Park, in rotting leaves, Forest Reefs (Lea).

The hairs among the pubescence are more conspicuous on some specimens than on others The head has a feeble median carina at the base, but it is sometimes concealed. On this, as on all others of the genus, the middle of the mesosternum is represented by a small (almost pointed) shining process, concealed with the head at rest, but distinct after it has been removed. On all of them the eyes are rather small

Deltocryptus ursus, n. sp.

Dark brown; antennae and tarsi paler. Densely clothed with rather long, depressed, pale pubescence, and with some suberect hairs scattered about

Head with dense and small punctures. Antennae with basal joint and three joints of club large, apical joint almost as wide and distinctly longer than either of the preceding ones. Prothorax with punctures as on head, but less distinct on account of clothing. Elytra with dense and minute punctures, and with rows of larger ones, becoming conspicuous on sides. Metasternum with dense but rather sharp punctures; median line deep and narrow, but somewhat wider and open posteriorly. Length, 2·5 mm.

Hab.—Tasmania: Hobart (A. M. Lea).

An oblong-elliptic species structurally rather close to the preceding one, but more densely clothed, the pubescence is longer and more conspicuous than on all the others here described, and on the upper surface of the type it is somewhat waved, but this may be accidental; on the abdomen it is almost as long as on the upper surface, and obscures the sutures from most directions The seriate punctures on the elytra are obscured by the clothing, so that it is difficult to trace a row throughout its length; but on each side there are three rows of larger ones that are rather conspicuous on the basal half, of these the outer one only curves around the apex so as almost to reach the suture. There is a concealed pectoral cavity, but it is for the reception of the tips of the mandibles, not for the antennae (as in *Dorcatoma)*, these being received in the bisinuations on the under surface of the head; the front coxae (normally concealed) are also pressed backwards, with their tips touching.

Deltocryptus aulacostethus, n. sp.

Blackish; head, elytra, and legs obscurely paler; tarsi and antennae much paler (almost flavous). With rather dense, depressed, ashen pubescence, interspersed with a few hairs.

Head with dense and small punctures. Basal joint of antennae and three joints of club large. Prothorax with punctures as on head, but less distinct on account of clothing. Elytra parallel-sided to near apex; with dense and small punctures, and with conspicuous rows of somewhat angular ones, becoming smaller posteriorly, but even there distinct. Under surface with dense and small punctures; median line of metasternum deep and wide. Length, 2 mm.

Hab.—New South Wales: Tamworth (A. M. Lea).

The seriate punctures on the sides of elytra are unusually large, so that they are distinctly wider than the interstices, even near the suture they are almost as wide as the interstices. With the head removed the median elevation of the mesosternum is quite conspicuous when viewed along the wide median line of the metasternum.

Deltocryptus microscopicus, n. sp.

Dark brown and somewhat shining; antennae and tarsi paler, metasternum almost black. With short, depressed, and not very dense, ashen pubescence, interspersed with suberect hairs.

Head with dense and small but rather sharp punctures. Antennae with basal joint and three joints of club large. Prothorax with base almost straight; punctures much as on head. Elytra widest near base, nowhere parallel-sided, with dense and small punctures, and with rows of rather large angular punctures, becoming larger and rougher on sides. Under surface with dense and small but rather distinct punctures; median line of metasternum deep and narrow. Length, 1-1·25 mm.

Hab.—New South Wales: Sydney, National Park, in rotting leaves (A. M. Lea).

A minute, elliptic-ovate species, at first apparently belonging to *Dorcatoma*, but with under surface of head deeply bisinuate for the reception of antennae, front coxae in contact, and median process of mesosternum quite distinct from behind, when the head has been removed.

Deltocryptus xyleboroides, n. sp.

Of a dingy castaneous-brown and subopaque, sutures of elytra and of metasternum narrowly infuscated; antennae flavous; with very short and inconspicuous pubescence.

Head with crowded and small punctures, with a thin median carina becoming acute posteriorly. Antennae with basal joint and three apical joints of club large. Prothorax scarcely one-fourth wider than long; densely and minutely punctate, middle of apical half minutely granulate. Elytra long and parallel-sided to near apex, surface shagreened or minutely punctate, with regular rows of rather large but shallow asperate punctures, becoming deeper on sides. Metasternum with dense but fairly sharp punctures; median line deep and narrow. Length, 2·75 mm.

Hab.—Queensland: Bundaberg (A. M. Lea).

An elongate parallel-sided species, in general appearance unlike the others here described, but with the under surface of head deeply bisinuate for the reception of antennae, front coxae in contact, and other generic details in conformity with them. Seen directly from above it has a striking resemblance to small Scolytidae of the genus *Xyleborus*.

Deltocryptus inamoenus, n. sp. Fig. 24.

Castaneous, parts of prothorax and of elytra slightly infuscated, antennae flavous; with short, depressed, pale pubescence.

Head and prothorax with dense minute punctures. Antennae with basal joint and three joints of club large. Elytra with dense and minute punctures, with large seriate ones confined to sides. Metasternum more shining, slightly darker and with sparser punctures than abdomen, median line deep and narrow. Length, 2 mm.

Hab.—South Australia: Tarcoola (A. M. Lea).

On the type there is a large infuscation on the prothorax and elytra about the scutellum, but its outlines are not well defined and it may not be constant. The sutural half of each elytron is without traces of striation, but on each side there are three rows of somewhat angular punctures, of which the outer row changes to a stria and is curved around the apex so as almost to touch the suture.

Deltocryptus funereus, n. sp.

Black or blackish, legs obscurely paler, antennae flavous; with short, depressed, pale pubescence.

Head with dense and small but fairly distinct punctures, becoming smaller on prothorax. Antennae with basal joint and three joints of club large, each joint, except the first and eleventh, acutely produced on one side. Elytra with dense and small punctures, with distinct rows on sides, but elsewhere without distinct ones. Metasternum more shining than abdomen, slightly darker, and with a rather wide median line. Length, 2 mm. (vix).

Hab.—South Australia: Barton (A. M. Lea).

Fairly close to the preceding species but much darker, metasternum with a wider median line and antennae different. In preparing an antenna for mounting in Canada balsam, the apical joint was lost, but it was of large size.

Anobium areolicolle, n. sp. Fig. 25.

Of a dingy brown, under surface somewhat darker than upper, palpi and usually parts of the tarsi paler. Densely clothed with short brownish pubescence, partly depressed, and partly sloping.

Head with dense, small, and even granules. Eyes prominent but not very large. Antennae extending to hind coxae, basal joint large, second rather small, third to eighth still smaller and somewhat serrated, ninth about as long as the six preceding joints combined, slightly longer than tenth, and slightly shorter than eleventh. Prothorax moderately transverse, deeply notched on each side of base, each notch bounded in front by an acutely produced part of the side; with two large areolets on each side, the first extending from the apex to one-third from the base and closed, the other latero-basal, smaller, and open externally; granules as on head but more obscured by clothing. Elytra parallel-sided to near apex; with rows of large quadrate punctures, the interstices moderately convex, about the width of the seriate punctures, and minutely granulate. Pectoral canal deep from apex of prothorax to basal third of metasternum, a narrow, deep, median line from thence to apex of the latter. Under surface with dense and small granules, basal segment of abdomen almost half the length of second. Length, 5-6 mm.

Hab.—Tasmania: Lakes district (Rev. T. Blackburn and Aug. Simson), Hobart (Commander J. J. Walker and A. M. Lea); Victoria: Dividing Range (Blackburn).

At first glance fairly close to *A. australiense (Hadrobregmus)*, but prothorax less gibbous in middle, the notch on each side of the base much larger, the projection before each notch larger and more acute, and the eyes much smaller. The pubescence of the under surface and legs is somewhat paler than on the upper surface, and in some lights has a slightly golden gloss. The lateral areolets of the prothorax are separated by an obtuse sinuous ridge. In the figure of the antennae the third to ninth joints (inclusive) are shown as rather longer than they should be.

Anobium angustifuscum, n. sp.

Dark brown; antennae, palpi, and parts of legs paler. Clothed with rather short ashen pubescence.

Head with dense and minute punctures. Eyes prominent but not very large. Antennae with basal joint rather large, second much smaller, third to eighth much smaller, ninth slightly wider and slightly longer than tenth, and slightly wider and shorter than eleventh, the latter as long as second to eighth combined. Prothorax somewhat gibbous in middle near base, sides somewhat

triangularly produced downwards, front angles strongly concave, the hind ones less so; punctures dense and small. Elytra thin, parallel-sided to near apex; with rows of rather large, subquadrate, but shallow and asperate, punctures, becoming shallower posteriorly; interstices scarcely separately convex, except on sides, where the striation is moderately deep, with minute punctures. Basal segment of abdomen about half the length of the following one, all with curved sutures. Legs long and thin Length, 3 mm.

Hab.—Tasmania (Rev. T. Blackburn).

A dark thin species. The front and middle coxae are conspicuously separated, but the intercoxal process of the mesosternum has an even slope, instead of being deeply concave, as in *A. domesticum* and closely allied species, and the median line of the metasternum is deep and wide on the posterior half, but absent from in front.

Pronus subhumeralis, n. sp. Fig. 26.

Dull castaneous-brown, legs and antennae paler; metasternum black or blackish, abdomen sometimes almost as dark. With very short, depressed, pale, uniform pubescence.

Head with minute punctures. Antennae eleven-jointed, basal joint and three joints of club large. Prothorax with minute punctures; margins somewhat projecting. Elytra parallel-sided to near apex; with rather fine but distinct striae, becoming deeper and containing more distinct punctures on sides; interstices with punctures as on prothorax. Metasternum with median line narrow; punctures minute. Abdomen with basal segment along middle fully as long as second or fifth, three median ones with straight sutures. Length, 2·75-3·5 mm.

Hab.—Lord Howe Island (A. M. Lea).

With some doubts this species is referred to *Pronus*, from the described species of which it differs in being considerably smaller and with smaller eyes; and the elytra with shallower striae, except on the sides, where they are deeper. It has the general appearance of the more elongate species of *Dorcatoma*, but the antennae pass over, instead of between the front coxae; the middle coxae are distinctly separated, but the space between them is transversely excavated and open, in *Dorcatoma* the cavity between them is concealed; in this species also the basal segment of the abdomen is large, and the legs are not capable of being received in special depressions. The male is usually slightly smaller and darker than the female, and his abdomen is sometimes almost black; both sexes usually have a latero-basal infuscation on each elytron, but it is sometimes absent, and its borders are never sharply defined. Specimens were obtained in abundance by beating shrubs over an umbrella. A badly-damaged specimen probably belongs to the species, but is almost entirely black or blackish.

Pronus marmoratus, n. sp.

Castaneous-brown or piceous-brown, sometimes almost black; antennae, palpi, and legs paler. Densely clothed with short ashen pubescence, darker in parts on elytra.

Head with dense minute punctures. Eyes small and prominent. Antennae with first joint and three joints of club large, second and third thin and moderately long, fourth to eighth shorter and feebly serrated. Prothorax with minute inconspicuous punctures. Elytra with puntcures as on prothorax, but towards and on each side with fairly well-defined striae, of which one curves around the apex and almost extends to the suture. Metasternum with a narrow median line; punctures as on upper surface. Two basal segments of abdomen large, the three median ones with straight sutures. Length, 2·25-3 mm.

Hab.—Norfolk Island (A. M. Lea).

In general appearance close to *P. subhumeralis*, but elytra without striae on sutural half, and with somewhat variegated pubescence. The males are usually darker than the females (several pairs were taken *in cop.*), sometimes their body parts being entirely blackish; the females are sometimes of a rather bright castaneous; but usually the metasternum and abdomen are darker than the prothorax and elytra; on pale specimens the suture is narrowly blackish. On each elytron the pubescence has several dark patches: a round one near the base and suture, a transverse postmedian one obliquely narrowed posteriorly, and a small subapical one, the three being sometimes narrowly joined together; the markings are usually quite distinct from certain directions, especially in the males, but on the females they are sometimes indistinct, and on abrasion are obscured or disappear. Numerous specimens were obtained by beating foliage. four were taken from fungi, and one from rotting leaves.

Calymmaderus.[10]

This genus is closely allied to *Dorcatoma* and *Mirosternus*, but is distinct by the club of the antennae, the basal joint of which is large, oblong, and as long as the two apical ones combined, or somewhat longer, the two apical ones are closely approximated, so as sometimes to appear but one The front coxae are widely separated, and there is a concealed sternal cavity, but when the head is removed a distinct median notch in the breast is exposed

Thaptor was proposed by Gorham for some Central American species, and an Australian one was referred to it by Pic, but the genus was subsequently considered as synonymous with *Calymmaderus*.

The Australian species before me may be thus tabulated:—

A Elytra without sharply impressed lateral striae . *pulverulens*
AA Elytra with one sharply defined stria on each side *unistriatus*
AAA Elytra with two on each side
  B Shining and with very minute pubescence .. .. .. *incisus*
  BB Opaque and with longer, but still short, pubescence . . *inconspicuus*

Calymmaderus pulverulens, n. sp. Fig. 27.

Dark piceous-brown and shining, antennae and legs paler. Pubescence minute

Head with dense and small punctures. Eyes large and with fairly large facets Antennae with basal joint large, second and third moderately large, fourth to eighth small, ninth as long as seven preceding combined and longer than two following combined. Prothorax with minute punctures, becoming more distinct on sides Elytra with small and minute punctures, striae feeble and lateral Metasternum with a narrow median line, and with irregularly distributed punctures Basal segment of abdomen distinct in middle, elsewhere almost concealed by the hind legs. Length, 3-3·25 mm.

Hab—Norfolk Island (A. M. Lea).

An elongate-elliptic, strongly convex, shining species, with pubescence so extremely short that it causes the surface to appear dusty, rather than clothed. On the elytra the subbasal lateral swelling has larger punctures than elsewhere, although small; behind it two feeble striae commence, and are traceable almost to the suture, but they are nowhere sharply defined.

(10) Solier, in Gay, Hist. d. Chile, Zool., iv., p. 472; Lacord., Gen. des Col., iv., p. 526.

Calymmaderus incisus, n. sp.

Bright castaneous and shining. With minute pubescence.

Head less shining than elsewhere; with dense and minute punctures. Eyes rather large and with large facets. Antennae with basal joint large, second moderately large, third to eighth small, ninth large, oblong, almost as long as the two following combined. Prothorax and elytra with minute punctures, striae of the latter confined to the sides. Metasternum with a narrow and rather deep median line. Basal segment of abdomen distinct only in middle, where it appears as a curvilinear triangle. Length, 2·75 mm

Hab.—Queensland: Brisbane (A. J. Coates).

A shining species approaching the preceding, but paler, and with two well-defined striae on each side of elytra; the striae are feeble near the base, but suddenly become deeper beyond the latero-basal swelling, they then curve around the apex, where the upper one terminates, the lower being continued almost to the suture. The sternal notch is continued to the base of the middle coxae.

Calymmaderus inconspicuus, n. sp. Fig. 28.

Of a dingy subopaque brown. Densely clothed with short, depressed, ashen pubescence.

Head with dense and minute punctures. Eyes rather large. Antennae with basal joint large, second moderately large; first joint of club thicker and slightly longer than two following combined. Prothorax and elytra with dense and small or minute punctures, the elytra with faint traces of discal striation, and with two deep striae on each side. Metasternum more shining and with larger punctures than elsewhere, a deep median line confined to posterior half. Basal segment of abdomen distinct only in middle. Length, 3 mm. (vix.).

Hab.—Lord Howe Island, unique (A. M. Lea).

An oblong-elliptic species, with the general outlines of *C. pulverulens,* but subopaque, and elytra with two sharply defined striae on each side, beginning quite close to the base, and both curving around the apex, but only the lower one almost touching the suture. The sternal notch is continued as a narrow triangle between the middle coxae.

Calymmaderus unistriatus, n. sp.

Piceous-brown and feebly shining; with very short, depressed, ashen pubescence.

Head with dense and minute punctures. Eyes rather large and with large facets. Antennae with basal joint large, second rather large, the next seven small, basal joint of club as long as the seven preceding joints combined, or the two apical ones combined. Prothorax with crowded minute punctures. Elytra with punctures as on prothorax, but in addition with faint rows of slightly larger ones, each side with one conspicuous stria. Metasternum with rather sharply defined punctures in front, median line narrow and deep on posterior half only. Basal segment of abdomen distinct in middle. Length, 4 mm.

Hab.—New South Wales: Illawarra (G. Compere).

An oblong-elliptic, dingy species, with the general outlines of *C. pulverulens,* but with a distinct stria on each side; there are faint traces of striation containing very feeble punctures on the disc of the elytra, and towards the sides the punctures and rows become more distinct; beyond the latero-basal swelling the outer row suddenly alters to a narrow stria, which is continued around the apex almost to touch the suture.

CAENOCARA.

This genus is closely allied to *Dorcatoma*, of which it is sometimes regarded as a section; and, as in that genus, the front coxae of its species are widely separated, to allow the passage of part of the antennae into a concealed sternal cavity; in the male the basal joint of its club, however, has a produced part more than twice as long as its support.

The two Australian species here referred to the genus have the first joint of the club strongly produced to one side as in the European *C. bovistae*, and the abdomen (except as to its punctures) is somewhat similar, but the eyes are much larger.

Caenocara insignicornis, n. sp. Fig. 29.

Pale castaneous and shining, suture of elytra and some marginal parts of sterna narrowly infuscated. Densely clothed with short, pale, semierect pubescence.

Head with minute punctures. Eyes large and with coarse facets. Antennae with basal joint and three joints of club large. Prothorax with minute punctures, more distinct on sides than in middle. Elytra with small punctures, striae confined to sides. Metasternum with a narrow median line. Abdomen composed of apparently four segments, the true basal one being almost entirely concealed by the hind legs. Length, 2·75 mm.

Hab.—Tasmania: Frankford (— Walken in Simson's collection).

The antennae are composed of eight joints, of which three form a club; the first of these has a produced part more than twice as long as its support, the second is strongly dilated to apex and incurved there, and the third is elongate-reniform. There are two striae on the side of each elytron, but they are faint on the basal third, then they suddenly become deep, and are so continued around the apical curve, when the upper one terminates, the lower one being continued so as almost to touch the suture.

This species is certainly congeneric with the New Zealand *Cyphanobium illustre*, Broun (which accordingly should be transferred to *Caenocara)*, but differs from it in being somewhat larger, less densely clothed, the male (the only sex known to me) with somewhat smaller eyes, the second joint of club very different from the first, instead of similar, and the apical one shorter and stouter; the female of that species has antennae as on many species of *Dorcatoma*. Broun described the antennae as being composed of eleven joints, but he was probably deceived by the pubescence; under a compound power I can only see eight joints.

Caenocara vigilans, n. sp.

Reddish-castaneous and shining, pronotum somewhat darker, elytra piceous-brown; with short, dense, suberect, whitish pubescence.

Head with small and sparse punctures. Eyes large, each slightly wider than the interocular space, and with rather large facets. Antennae with basal joint and three joints of club large. Prothorax with minute punctures. Elytra with dense and minute punctures; striae confined to sides. Abdomen apparently composed of but four segments, the basal one being almost entirely concealed. Length, 2 mm.

Hab.—Northern Queensland (Blackburn's collection).

Differs from the preceding species in being smaller, narrower, and darker, eyes larger, and basal joint of club with a longer process. In appearance it is strikingly close to *Dorcatoma antennalis*, and it has similar striation, but the eyes are larger, club considerably larger, with the produced part of its basal joint almost thrice as long as its support, hence the species was referred to *Caenocara* rather than to *Dorcatoma*. There are two deep striae on the side

of each elytron, commencing near the base, and terminated evenly almost at the suture. Only one antenna is left on the type, so it was not detached for examination under a compound power, and I was unable to count the joints between the large basal one and the club.

Dorcatoma.

Unset specimens of this genus have the head with the tips of the mandibles resting on the intercoxal process of the metasternum, entirely concealing the middle of the prosternum, mesosternum, and the front coxae, with the antennae and legs received in appropriate cavities, so as not to interrupt the continuity of outlines. When the head and prothorax are removed, it may be seen that a large cavity exists in the metasternum for the reception of the joints of the clubs, and that the mesosternum has been forced back, so as to appear as a vertical wall on each side, and to be quite concealed in the middle by the over-lapping intercoxal process of the metasternum, much as in the Hawaiian genus *Mirosternus*, but they are without the deep and wide median line on the meta-sternum, characteristic of that genus; the front coxae are widely separated, so as to allow of the passage of part of the antennae to the concealed cavity. The eyes vary considerably in size, but their facets are usually large. They all have the basal joint of antennae large, and the three apical ones large (usually very large), and forming a loosely compacted club, of which the first and second joints are more or less triangular, the intervening joints are small and difficult to count. The abdomen of most species from the sides appears to be composed of four segments, with the sutures well defined, but the sutures often tend to obliteration, or at least to become indistinct in the middle; the true basal segment is normally concealed by the hind legs, except in the middle, where it appears as a small intercoxal process, and the extreme margins, which sometimes appear as narrow shining rims behind the coxae. They all have short, more or less uniform, pubescence or setae, usually erect or suberect, but occasionally depressed. The Australian species here referred to the genus may be roughly divided into two sections:—1. Those of a short, broad, "dumpy" form, usually with fine striae near the suture of elytra, as well as stronger ones on the sides, and those of rather more elongate but still compact form (as the European *D. chrysomelina* and *D. flavicornis)*, with elytral striation usually confined to the sides, and basal segment of abdomen more distinct. The head of at least one specimen of every species, here described, has been detached from the body, so that the coxae and concealed parts of the sterna could be examined, as well as the under surface of the head itself; and an antenna of each was usually mounted in Canada balsam, for examination under the microscope. The tarsi are usually paler than the rest of the legs, but they are normally concealed.

Gorham[11] considered *Dorcatoma* contained forms with 11, 10, and 8 joints to the antennae, and that *Caenocara* was only a section of it. *D. lanigera*, Oll., is here commented upon as the type of a new genus, *Aulacanobium*.

Table of Australian Species of *Dorcatoma*.

A. Head with a Y-shaped impression between eyes	*interocularis*
AA. Head with two deep longitudinal grooves joining clypeal suture ..	*bisulciceps*
AAA. Head without special impressions behind clypeal suture.	
B. Elytra with rows of large punctures on sides near base.	
a. Punctures enclosed within the striae	*norfolcensis*
aa. Punctures extending beyond the striae	*punctilatera*
BB. Elytra without rows of large punctures on sides near base.	
C. First joint of club much wider than long.	
b. Almost circular; eyes rather small	*subcircularis*
bb. Elliptic-ovate; eyes large	*antennalis*

(11) Gorham, Biol. Cent. Amer., Coleoptera, iii., part 2, p. 208.

CC. First joint of club longer than wide, or scarcely wider than long.
D. Elytra without distinct lateral striae; club blackish.
c. Pubescence wavy .. .. *rhizobioides*
cc. Pubescence not wavy . .. . *elliptica*
DD. Elytra with distinct lateral striae.
E Each elytron with one stria or none between the suture and lateral ones.
d. Each side with three distinct striae .. . . *atripennis*
dd. Each side with less than three striae.
e. Eyes large .. .. *punctipennis*
ee. Eyes small .. .. *marginalis*
EE Each elytron with two striae between the suture and lateral ones.
f More than 2 mm. long .. . . *modica*
ff Less than 2 mm long .. .. *minima*
EEE Each elytron with more than two striae between the suture and lateral ones.
F Elytra at basal third with striae at regular intervals from suture to sides.
g. Eyes large; elytra castaneous .. .. . . *irrasa*
gg Eyes small; elytra deep black .. .. *aterrima*
FF Elytra with an interval between suture and each side where no striae are traceable
G. Conjoint width of eyes equal to or wider than interocular space.
h More than 2·5 mm. long .. . . *macrops*
hh. Less than 2·5 mm long .. . . *simulans*
GG Conjoint width of eyes less than width of interocular space.
H. Less than 3 mm. long .. .. *tasmaniensis*
HH Not less than 3 mm. long .. . . *corticalis*

NOTES ON TABLE.

E, EE, and EEE. The striae near the suture are usually faint, but are traceable in certain lights.

hh. On *D. simulans,* in some lights, very faint striation may be traced beyond the shoulders, but it is very feeble and invisible from most directions.

Dorcatoma interocularis, n. sp. Fig. 30.

Dark piceous-brown, sterna almost black, antennae paler; with short, suberect, pale, setose pubescence.

Head finely granulate or shagreened, with a Y-shaped impression between eyes; clypeal suture deep, with two small impressions touching its hind edge. Antennae apparently ten-jointed, first joint large, second moderately large, the five following ones small, but two of them produced to one side; first joint of club large, produced on one side and rounded there, second subtriangular, third slightly longer and thinner. Prothorax with dense and small punctures. Elytra with similar punctures, with fine but distinct striae almost or quite disappearing posteriorly, except that on each side there is a conspicuous one from base to apex. Under surface with more distinct punctures than upper surface; metasternum with larger and sparser punctures than abdomen, and with a very narrow and faint median line. Length, 3 mm.

Hab.—New South Wales: Wollongong (A. M. Lea).

Very distinct from the other Australian species by the Y-shaped impression on the head, its three parts are narrowly impressed, but the Y itself is rather wide. The abdomen appears to be composed of but four segments, as only minute parts of the true basal one are visible. The legs of the type have not been removed from their cavities, but as the head has been detached the front coxae are seen to be widely separated. The eyes are of moderate size, and with rather large facets.

Dorcatoma bisulciceps, n. sp.

Blackish, prothorax and abdomen obscurely paler, antennae obscurely reddish. Pubescence short and pale.

Head with two, deep, narrow grooves, close together from about half-way between eyes, to where they terminate in the deep clypeal suture. Antennae with basal joint and three joints of club large, the intervening ones small and apparently five in number. Prothorax with minute punctures. Elytra with fairly distinct punctures, with fine striae on disc almost disappearing posteriorly, each side with three well-defined striae towards base, but only one continuous to apex. Under surface as described in preceding species. Length, 3 mm.

Hab.—New South Wales (Blackburn's collection); Queensland. Mount Tambourine (A. M. Lea).

In appearance close to the preceding species, but slightly darker, elytra with lateral striae more distinct towards base, and head with two deep longitudinal grooves. The pubescence is semierect and appears to be easily abraded, as one specimen has most of the upper surface glabrous. Under a fairly high power of the microscope I can count only five joints between the large basal joint of antennae and the club, so that the antennae appear to be nine-jointed; it is probable, however, that they really have ten joints.

Dorcatoma irrasa, n. sp. Figs. 16, 17, 31

Castaneous. Uniformly clothed with short, semierect, setose pubescence.

Head with inconspicuous punctures. Eyes large, facets rather small. Antennae with basal joint and three joints of club large. Prothorax with small and rather dense punctures, larger on flanks than in middle. Elytra with dense and small punctures, striation fine but well defined, except on parts of apical slope, deeper on sides than elsewhere, but only one stria on each side traceable to apex. Metasternum with sparser and more sharply defined punctures than on upper surface; median line feeble. Abdomen apparently composed of four segments, the first being almost entirely concealed. Length, 2·75-3 mm.

Hab.—Western Australia: Donnybrook (A. M. Lea).

A comparatively large castaneous species, the elytra with distinct striation, except on parts of the apical slope, where, owing to the greater density of the punctures, they are indistinct or absent. Some specimens are slightly darker than others, and some have the legs and mandibles perceptibly darker than the sterna and abdomen. Under a hand lens the antennae appear to be composed of a large basal joint, two small following ones, and a club of three large joints; but under a compound power they are seen to be eleven-jointed.

Dorcatoma corticalis, n. sp.

Blackish-brown, sterna black, club reddish. With uniform, short, semierect, ashen pubescence.

Head opaque and with crowded but rather sharply defined punctures. Eyes not very large, but with rather large facets. Antennae with basal joint large and a club of three large joints, the intervening joints small and seven in number. Prothorax with dense, partially concealed, punctures. Elytra with two deep striae on each side, one short, the other traceable to apex, elsewhere with fine striae, but disappearing about apical slope, where the punctures are denser than elsewhere. Metasternum with a narrow but well-defined median line. Length, 3-3·75 mm.

Hab.—South Australia: Adelaide, Pillaworta, under bark (Rev. T. Blackburn), Mount Lofty (S. H. Curnow, A. H. Elston, and J. G. O. Tepper); Tasmania: Launceston (Aug. Simson).

Structurally close to *D. irrasa,* but darker, with denser and somewhat larger punctures, head less shining, and with smaller eyes; as on that species the true basal segment of abdomen appears as a narrow shining rim behind the hind coxae. Under the microscope the antennae appear to be almost exactly as in fig. 31. At first glance t... specimens appear to be entirely black, but on close examination the metasternum and legs are seen to be darker than the adjacent parts, the club is pale, but is normally concealed. For a short distance there are two deep striae on the side of each elytron, but only one is continuous. As viewed back downwards the sides and apex of abdomen appear to be enclosed by a double elytral margin, but one of these margins really consists of a narrow edging of the abdomen itself; a somewhat similar but less conspicuous double edging may be seen on other species.

Dorcatoma macrops, n. sp.

Blackish, head and antennae paler. With short, more or less erect, ashen pubescence.

Head, antennae, and prothorax as described for *D. irrasa.* Elytra with more distinct punctures than on prothorax, striation well defined near suture, faint or absent about middle and about apical slope, each side with three deep striae near base, but only one of these traceable to apex. Metasternum with a well-defined but narrow median line. Length, 2·75 mm.

Hab.—New South Wales: Illawarra (G. Compere).

Structurally close to *D. irrasa* but darker, and smaller than the average size of that species, with the median line of metasternum more sharply defined; in colour it is nearer to *D. corticalis,* but the lateral striae more nearly resemble those of the first-named one. So far as the antennae could be examined under the microscope, without detaching them from the head, they appear to be composed of eleven joints, as in *D. irrasa,* but the first joint of the club is more pointed inwards (triangular) than on that species. Of the two specimens taken by Mr. Compere one has the metasternum and abdomen of the same shade of colour, on the other the metasternum is slightly the darker. A specimen from Queensland (Mount Tambourine, A. M. Lea) probably belongs to the species, but the elytral striae are somewhat fainter, and the abdomen and head are uniformly reddish.

Dorcatoma tasmaniensis, n. sp. Fig. 32.

Deep black, prothorax obscurely diluted with red, head slightly paler, club of antennae still paler. With short, ashen, semiupright pubescence, sparser on elytra than elsewhere.

Head shining and with rather inconspicuous punctures; clypeal suture deep and moderatly curved. Eyes comparatively small. Antennae with basal joint and three joints of club large, the intervening ones small. Prothorax with dense and small punctures. Elytra with slightly larger punctures than on prothorax, striation distinct in parts. Metasternum with median line very narrow but distinct. Length, 2·5 mm.

Hab.—Tasmania (Aug. Simson), Hobart, from fallen leaves, Latrobe, in flood *débris,* Mole Creek (A. M. Lea).

Structurally close to *D. macrops,* but smaller and somewhat wider in proportion, eyes distinctly smaller, median line of metasternum thinner and less deep, and abdominal sutures less distinct across middle. There are three fairly distinct striae and a feeble one (the latter sometimes absent) on each side of the suture from near the base to about the middle, when they disappear; on each side there are three well-defined ones, but only one of these extends to

the apex. There are probably eleven joints to the antennae, but I can only count six between the large basal joint and the club.

Dorcatoma modica, n. sp. Fig. 33.

Dark castaneous-brown, head and antennae paler. With short suberect pubescence.

Head shining and with small punctures. Antennae with basal joint and three joints of club large. Eyes large and with rather large facets Prothorax with minute punctures, becoming somewhat larger on sides. Elytra with small but rather sharply defined punctures, striation distinct near suture and on sides. Metasternum with median line very narrow, but slightly dilated at the ends. Length, 2·5 mm.

Hab.—Northern Queensland (Blackburn's collection), Cairns (E. Allen).

About the size of *D. tasmaniensis*, but less dark, with decidedly larger eyes and median line of metasternum different. Each elytron has two fairly distinct striae near the suture, of which the first terminates slightly beyond the middle, the second slightly before it, there are three deep striae on each side, but only one of these curves round so as almost to touch the suture. The antennae are probably eleven-jointed, but even under a fairly high power of the microscope I could not count the number of joints between the large basal one and the club.

A specimen from southern Queensland (Dalby, Mrs. F. H. Hobler) probably belongs to this species, but is smaller, 2·25 mm., rather less dark, and of the striae near the suture the first is feeble and the second is traceable with difficulty.

Dorcatoma antennalis, n. sp. Fig. 34.

Black, head and abdomen obscurely reddish, antennae paler. With short, dense, suberect, pale pubescence.

Head shining and with minute punctures. Eyes large and with rather large facets. Antennae with basal joint, and three joints of club large. Prothorax with fairly distinct punctures on sides, but feeble elsewhere. Elytra with minute punctures, striae distinct only on sides. Median line of metasternum very narrow. Length, 2·25 mm.

Hab.—Queensland: Cairns (A. M. Lea).

At first glance apparently belonging to the preceding species, but distinct by the sides of elytra and antennae; each side has two deep striae commencing near the base, and curved round so as almost to touch the suture, and a shallower marginal one that connects with the sutural stria; the sutural one is distinct on the apical slope, elsewhere it is faintly traceable only in certain lights. The first joint of the club has a produced part almost twice the length of its support, and denoting an approach to *Caenocara,* the second is triangularly dilated to the apex, with the apex slightly incurved, and the apical joint longer but thinner than the others. I could not count the joints between the first and the club, but they are certainly more than four in number. The elytral pubescence from certain directions appears to be slightly lineate in arrangement.

A specimen from northern Queensland (Blackburn's collection) appears to belong to this species, but is smaller (2 mm.) and mostly castaneous, the elytra only being of a rather dark brown.

Dorcatoma simulans, n. sp.

Dark brown, head and abdomen paler, antennae still paler. With dense, short, pale, suberect pubescence.

Head shining and with small punctures. Eyes large, with rather large facets. Antennae with basal joint and three joints of club large. Prothorax

with minute punctures, becoming larger and denser on sides. Elytra with rather sharply defined punctures, striation distinct near suture, feeble in middle, deep on sides. Median line of metasternum narrow. Length, 2-2·25 mm.

Hab.—Northern Territory: Darwin (W. K. Hunt).

In general appearance close to *D. modica* and with similar eyes and antennae, but elytral striae different; on each elytron there are two distinct striae near the suture (but vanishing on the apical slope), then some feeble ones, but sufficiently clear in certain lights, then three well-defined ones on the side; of these the first is short, the next extends to about level with the base of the subapical segment, and the third is deepened and curves around so as almost to touch the suture. From some directions the elytral pubescence appears distinctly lineate in arrangement. Two of the seven specimens before me have the elytra and metasternum almost black, another is almost entirely castaneous.

Dorcatoma aterrima, n. sp.

Deep shining black, antennae obscurely reddish.

Head with minute punctures. Eyes much smaller than usual. Antennae with basal joint and three joints of club large. Prothorax with minute punctures, becoming comparatively large on sides. Elytra with rather sparse but well-defined punctures on basal half, becoming crowded posteriorly; basal half with well-defined striae, becoming longer on sides, but only one traversing the densely punctate space so as almost to touch the suture. Metasternum with a narrow median line, and with distinct punctures, but much sparser than on abdomen. Length, 2·5 mm.

Hab.—New South Wales (Blackburn's collection).

The intensely black colour and the comparatively small eyes readily distinguish the present species from the others here referred to *Dorcatoma,* it appears to be nearest of all to *D. tasmaniensis,* but has smaller eyes and more distinct striation; the dense punctures on the posterior half of the elytra cause the surface to appear shagreened, and interrupt all the striae except a deep submarginal one. On the type there is a slight amount of pubescence on the sides of prothorax, on the shoulders and about the apex of abdomen, elsewhere the surface is shining and glabrous; but probably it has been much abraded, thus rendering the punctures and striae unusually distinct.

Dorcatoma atripennis, n. sp.

Black, prothorax, and abdomen obscurely paler, head and antennae slightly paler still With short, suberect, ashen pubescence.

Head shining and with minute punctures. Eyes of moderate size and with rather large facets. Antennae with basal joint and three joints of club large. Prothorax with small punctures, but becoming larger on sides. Elytra with small and rather dense punctures, striation distinct only on sides. Length, 2 mm.

Hab.—Northern Queensland (Blackburn's collection).

At first glance apparently belonging to *D. antennalis,* but first joint of club and elytral striation very different. The second joint of the antennae is of moderate size, but between it and the club the articulation is indistinct; the first joint of the club is strongly rounded on its inner side, and not as wide as long, the second is subtriangular, and the third thinner (in preparing the antennae of the type for mounting in Canada balsam, the apical joint of each was lost). There is but one stria on each elytron near the suture, faint on the basal half, and not traceable elsewhere; on each side there are three distinct ones, of which the inner one is narrower and shorter than the others, the latter about the middle are conjoined to continue as a deep one, which curves around

the apex almost to the suture. The median line of the metasternum is wider than in any of the preceding species, it is fairly deep near the base, and becomes shallower and wider posteriorly; the abdominal sutures are very indistinct across the middle.

Dorcatoma punctipennis, n. sp. Fig. 35

Reddish-castaneous, metasternum darker, elytra still darker (mostly almost black). With short, dense, suberect, pale pubescence

Head shining and with minute punctures. Eyes large and with rather large facets. Antennae with basal joint and three joints of club large Prothorax with minute punctures, becoming larger and denser on sides. Elytra with rather dense and small but sharply defined punctures, striation confined to sides. Metasternum more convex and with somewhat denser punctures than usual in the middle, but sparser elsewhere; median line traceable only at ends Length, 2 mm.

Hab—Lord Howe Island (A M. Lea)

Close to *D. modica*, and with very similar eyes, but basal joint of club more triangularly produced on one side, and each elytron with only one distinct stria The first and second joints of the club are triangular, but the first is wider than long, the second longer than wide; under a fairly high power of the microscope I could only count four joints between the large basal joint of the antennae and the club The distinct stria on each elytron is near the side, and begins level with the hind coxa, it then curves around so as almost to touch the suture, but between it and the outer margin a very faint one may be traced A second specimen differs from the type in being decidedly smaller (1½ mm.), somewhat paler, with the median line of metasternum faintly traceable in the middle, and the elytral punctures rather less sharply defined; it probably belongs to the species, but its antennae were not examined

Dorcatoma minima, n. sp.

Reddish-castaneous, elytra and metasternum slightly darker than elsewhere, club of antennae paler. With short, semierect, pale pubescence

Head shining and with minute punctures. Eyes rather large and with large facets. Antennae with basal joint and three joints of club large Prothorax with small punctures on sides, minute elsewhere. Elytra with dense and small punctures, striation faint except on sides. Median line of metasternum narrow but distinct. Length, 1·25 mm.

Hab.—Queensland: Dalby (Mrs. F. H. Hobler).

A minute species, smaller and somewhat narrower than any of the preceding ones. There are two short striae on each elytron near the suture, but they are very faintly indicated, and are invisible from several directions; there are three striae near each side, but of these two are rather feeble and short, only one being deep and curved around so as almost to reach the suture. I was unable to count the number of joints of antennae between the first and the club.

Dorcatoma subcircularis, n. sp. Fig. 36.

Deep shining black, antennae reddish. With short, semierect, whitish pubescence.

Head with rather sparse and small punctures. Eyes not very large, facets rather small. Antennae with basal joint and three joints of club large. Prothorax with rather small but sharply defined punctures, becoming denser and

larger on sides. Elytra conjointly slightly wider than long; with rather sharply defined punctures, striae confined to sides. Metasternum rather strongly convex; with comparatively coarse punctures; median line scarcely indicated. Length, 1·25 mm.

Hab.—Northern Queensland (Blackburn's collection).

An unusually compact species (1·5×1·25×1 mm.), readily distinguished by its almost circular outline, deep black colour, and by the triangular production of the basal joint of the club of antennae (the produced part being almost twice as long as its support) indicating an approach to *Caenocara*. Its antennae and striae are nearer those of *D. antennalis* than any other species, but it is conspicuously wider and darker. On the elytra there are no striae near the suture, but the punctures there have a faintly lineate appearance; on each side there are three deep striae, one of which is very short, the others curve around the apex, but one approaches more closely to the suture than the other. Under a fairly high power of the microscope I could not count more than five joints between the basal joint of antennae and the club.

Dorcatoma punctilatera, n. sp. Fig. 37.

Dark piceous-brown, antennae and legs paler. With dense, short, suberect, ashen pubescence.

Head shining and with minute punctures. Eyes not very large but with rather large facets. Antennae with basal joint and three joints of club large. Prothorax with dense and minute punctures, scarcely larger on sides than in middle. Elytra with slightly larger punctures than on prothorax, and with more or less regular rows of slightly larger ones, becoming conspicuous on sides. Metasternum with median line narrow but distinct on apical half, not traceable towards base. Length, 2-3 mm.

Hab.—Lord Howe Island (A. M. Lea).

Some specimens are darker than others, their elytra and sterna being black or almost so, on many the head and abdomen are paler than the adjacent parts, but not as pale as the antennae and legs. At first the elytra appear to be faintly striated, with the striae deep on the sides, but this appearance is caused by rows of small punctures, with the interstices faintly undulated; on each side there are three conspicuous rows of punctures, of which the uppermost is short, the other rows consist of larger punctures, but posteriorly they become smaller, and one row really alters to a stria, which almost touches the suture. On the under surface of the head there are two rather small subfoveate impressions near the base (but not deeply bisinuate impressions, as in *Lasioderma* and allies); and the front coxae are widely separated, to allow the passage of the apical joints of antennae into the normally concealed sternal cavity. Numerous specimens were obtained by beating shrubs; one was taken from a tree-fern, and another from fallen leaves. Two small specimens are entirely bright castaneous, except that the antennae and parts of the legs are almost flavous; on one of them the seriate punctures on the elytra are also larger.

This and all the following species, regarded as of the second group, are more or less oblong-elliptic, with the elytra partly parallel-sided; on all the preceding species, regarded as of the first group, the shape is more elliptic-ovate, with the elytra bulging out where they join the prothorax; their abdominal sutures (unless otherwise noted) are clearly indicated in the middle. The legs appear to be capable of being received into cavities quite as deeply as in those species, but as seen they are usually partly free.

Dorcatoma norfolcensis, n. sp. or var.

Dark brown or blackish, antennae and parts of legs reddish. Length, 2·25-2·75 mm.

Hab.—Norfolk Island (A. M. Lea).

Nine specimens from Norfolk Island differ from specimens of the preceding species in having the rows of punctures on the elytra (except the lateral ones) scarcely, if at all, indicated; the punctures in the three outer rows are somewhat smaller than on that species, and those of the outermost row appear to be confined to a stria, and are not as wide as the interstice between two rows; on the preceding species the punctures in the basal half of the outer row extend beyond the limits of the stria, and are distinctly wider than the interstice between two rows. They are also slightly less robust and have somewhat larger eyes (in both sexes); but it is possible that they should be regarded as representing a varietal or subspecific form only.

Dorcatoma rhizobioides, n. sp. Fig. 38.

Black, parts of antennae and of legs reddish. Densely clothed with short, depressed, pale-ashen pubescence, somewhat waved on upper surface.

Eyes small and prominent. Antennae with basal joint and three joints of club large. Elytra faintly undulated. Metasternum with median line rather narrow but somewhat dilated in middle. Basal segment of abdomen rather short behind coxae, but distinct from side to side. Length 2·25-2·5 mm.

Hab.—Norfolk Island (A. M. Lea).

A narrow species with wavy pubescence (as on many small Coccinellidae); the sides of the elytra are faintly undulated but are non-striated. The punctures are concealed by the pubescence, but appear to be everywhere dense and very minute. The antennae are ten-jointed and dark, almost black, except that the small joints between the basal one and the club are almost flavous; the two basal joints of the club are triangularly dilated to, and incurved at, apex; on the male they are considerably larger than on the female. Seven specimens were obtained. It is smaller and darker than the New Zealand *D. oblonga,* but is close to it in many respects.

Dorcatoma elliptica, n. sp. Fig. 39.

Black, small joints of antennae and parts of legs reddish. With short, depressed, ashen pubescence.

Eyes small and prominent. Antennae with basal joint and three joints of club large. Elytra with faintly impressed rows of punctures on sides towards base, but disappearing posteriorly. Metasternum with median line distinct on posterior two-thirds, and narrowly impressed along its middle. Basal segment of abdomen rather short but distinct from side to side. Length, 2·5 mm.

Hab.—Lord Howe Island (A. M. Lea).

A narrow species, structurally close to *D. rhizobioides,* and with very similar antennae, but pubescence not at all waved, and faint punctures on sides of elytra, not becoming sharply impressed striae as on species of the first section of the genus; elsewhere the punctures are very minute and normally concealed by the clothing.

Twelve specimens from Tasmania, Kelso (Aug. Simson), Wilmot (H. J. Carter and A. M. Lea), Hobart, Ulverstone, and Marrawah (Lea) differ in being somewhat larger (up to 3 mm.), and with the punctures at sides of elytra even less distinct, two of them also have the elytra obscurely diluted with red (the margins rather more noticeably); but I can find no differences warranting their being considered as specifically distinct.

Dorcatoma marginalis, n. sp.

Piceous-brown, antennae and parts of legs paler. With short, suberect, ashen pubescence.

Head with dense and minute punctures. Eyes small and with rather large facets Antennae with basal joint and three joints of club large, first joint of club slightly longer than its apical width and slightly larger than second. Prothorax with dense and minute punctures, becoming somewhat larger on sides. Elytra with dense and small punctures; striae confined to sides. Metasternum with median line very narrow but continuous from base to apex Abdominal sutures scarcely traceable across middle. Length, 2·5 mm.

Hab.—Victoria: Alps (Rev. T. Blackburn).

The elytra are without the least evidence of striation near the suture; on each side near the base there are very feeble striae, but beginning level with the hind coxa there are two distinct ones, the upper short, the other deepened and continued around the apex so as almost to touch the suture The first joint of the club not wider than long at once distinguishes the species from *D. antennalis* and *D. subcircularis*, whose lateral striae are also deeper and longer; *D. atripennis* is a smaller and darker species, with longer and stronger lateral striae; *D. punctipennis* is darker, with stronger elytral punctures and much larger eyes. On the type the head and abdomen are obscurely paler than the elytra and metasternum. I could not count the number of joints in the antennae between the large basal joint and the club

BLACKBURNIELLA, nov. nom., FOR THANASIMOMORPHA, Blackb. (COLEOPTERA: CLERIDAE).

By Edward A. Chapin, Ph.D., Washington, D.C.

(Communicated by Albert H. Elston, F.E.S.)

[Read May 8, 1924.]

The International Code of Zoological Nomenclature in its present form is framed with the avowed intention of removing, as far as possible, the personal element from among the factors upon which any case is decided. For this reason, it would seem to the writer that when any case arises which is not completely or definitely covered by the Code, its solution should, if possible, depend on factors applicable to all similar cases and not upon points which have a peculiar bearing on the individual case.

The subject under discussion at present is the genus *Thanasimomorpha*, Blackburn, 1891, of the Coleopterous family Cleridae In a recent paper, Mr Albert H. Elston advocates the suppression of the original type designation of the genus because of an obvious misidentification, and designates as genotype another of the originally included species. If Mr. Elston's argument is accepted, a precedent is established which will quite probably open the way for numerous changes in the names of genera erected by Fabricius, DeGeer, and other early workers.

The Rev. H. S. Gorham, in 1877, made the following statement in regard to *Tillus bipartitus*, Blanchard:—"The former most resembles a *Thanasimus*, but has the palpi all securiform; . . . *Tillus hilaris*, Westwood, is congeneric with *bipartitus*, which it much resembles." From this it is evident that Gorham had an erroneous idea of both the above-mentioned species, for, thanks to Lesne's re-examination of the type of *bipartitus*, Blanch., we definitely know the first-mentioned species to be a synonym of *Tillus notatus*, Klug., while the second is known to be very closely related to *Tarsostenus univittatus*, Rossi.

In the Transcactions of this Society for 1891, page 304, the Rev. Canon Blackburn proposed the new genus *Thanasimomorpha* as follows:—

"*Thanasimomorpha* (gen. nov.). Thanasimo affinis; different palporum maxillarium articulo ultimo securiformi. The Rev. H. S Gorham (Cist. Ent., ii., p. 62) points out the necessity of a new genus for *Tillus bipartitus*, Blanch., but without proposing one. I therefore suggest the above name. Another member of the genus (as Mr. Gorham points out) is *Clerus guttulus*, White."

This is followed by the description of *(Thanasimomorpha) intricata*, n. sp., said to be related to *bipartitus*, Blanch.

It is obvious that Blackburn's generic diagnosis is a translation of the remark of Gorham without augmentation. The citation of Gorham as authority for the inclusion of *Clerus guttulus*, White, in the genus is contrary to fact. There is no evidence of personal knowledge of the species involved here, and, again, there is evidence of misidentification of species, for *guttulus*, White, is a *Tarsostenodes*, and is quite unlike either a *Tillus* or the insect known as *Thanasimomorpha intricata*.

It is Elston's contention that a misidentification is evident, that the species *intricata* is closely related to the insect assumed by Blackburn to be *bipartitus*, Blanch., that the *bipartitus* of Blackburn (an unnamed species) is definitely

known, and that the selection of *intricata*, Blackb., would conform with the conception of *Thanasimomorpha* as held by Blackburn. This is undoubtedly true, for the external evidence in the form of Blackburn's collection and his subsequent written work is at hand. It is true, however, that the inclusion of *guttulus*, White, by Blackburn in the genus introduces evidence detrimental to Elston's case. Even if the Code permitted such a solution as Elston proposes, it is sufficient, I believe, to prevent any such settlement from being permanent. On the other hand, *Tillus bipartitus*, Blanch., is the type of *Thanasimomorpha*, Blackb. Of this there can be no doubt. Blackburn selected the species, so far as one can know from his paper, in good faith. Here, at least, is a solution of the problem which, though unpleasant, is not open to attack. Let us grant that the type of a genus is that species which the author, or some later worker, designates, and allow the generic name to stand or fall, as its designated type stands or falls, regardless of misidentification.

Many genera are based on Linnean species. In many cases, there is external evidence to show that the Linnean species was misidentified by the author of the genus. More often there is no evidence one way or another. The only hope of salvation for the nomenclature, already so unwieldy as to almost overpower us, is to accept definite statements of type as fact regardless of external evidence to the contrary.

For the reasons expressed above, I believe it necessary to consider *Thanasimomorpha*, Blackb. (type, *Tillus bipartitus*, Blanch.), as a synonym of *Tillus*, Oliv., and to select a name for the genus of which *intricata*, Blackb., is a member. There appears to be no available published name. At one time it was thought that a case could be made for the retention of *Thanasimorpha*, a form apparently first used by Lodhe, 1900. However, this name is obviously the result either of a *lapsus calami* or a typographical error, it matters not which. As such it is subject to correction according to the Code, and a solution based on this name would be no solution at all. These being the facts as they appear to me, I propose the new genus *Blackburniella*, with *Thanasimomorpha intricata*, Blackb., as type species. I fully appreciate Mr. Elston's point of view, both as published and indicated in personal letters, and I interfere with *Thanasimomorpha* only with deep regrets.

THE FLORA AND FAUNA OF NUYTS ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 16.—THE CRUSTACEA.

By Herbert M. Hale, South Australian Museum.
(Contribution from the South Australian Museum.)

[Read May 8, 1924.]

Plates IV. and V.

The following list of the Crustacea collected includes specimens dredged from the "Conqueror," in 3 to 4 fathoms, in the neighbourhood of the group of islands forming Nuyts Archipelago; others captured on Pearson and Flinders Islands, and a few examples taken on the mainland opposite to the Archipelago.

DECAPODA

Suborder Natantia.

Tribe CARIDES.

Family PANDALIDAE

Pandalus, Leach.

Subgenus Parapandalus, Borradaile.

In recording some specimens taken by the Expedition, it seems advisable to here discuss the forms taken in South Australian waters.

Pandalus (Parapandalus) leptorhynchus, Stimpson.

Pl. iv., figs. 1-5.

Pandalus leptorhynchus, Stimpson, Proc Acad. Nat. Sci, Philad., xii., 1861, Sp. 447; Haswell, Cat. Aust. Crust., 1882, p 197.

Form very slender in male, slightly more robust in female. Rostrum subfiliform, tapering, scarcely compressed, a little upwardly curved, slightly shorter or slightly longer than scaphocerites, distinctly longer than antennular peduncles, and less, or a very little longer, than the medial length of carapace; a slender, immovable, spine-like tooth on upper surface near base and from two to five smaller ones below, the first situated usually at about the middle of the length, the minute anterior one close to the acute rostral tip. First joint of antennular peduncle about twice as long as the second and third together, constricted in the middle and bent upwards in front of the constriction; base broad and produced laterally to form a scale with an acute apex, which does not attain to the level of the apex of the first peduncular joint; flagella subequal in length, longer than the peduncle. Scaphocerite rounded distally, the spine at termination of outer margin small. A distinct ocellus on dorsal margin of eye. Carapace with a slender median spine immediately behind base of rostrum, which forms a weak crest on the anterior portion of the carapace. Third segment of the abdomen with a depression on each side of the posterior margin, which is thus a little compressed to form a rounded median carina. Sixth segment twice as long as greatest width and about as long as telson. External maxillipeds not quite reaching to apex of antennal scale. First pair of legs very slender, extending as far forward as maxillipeds. Carpos of second pair three-jointed,

the second and third joints together about one-ninth longer than first, which is almost twice as long as the third; third pair longest, extending slightly beyond apex of antennal scale. Last three pairs slender, with the claw-like dactylus folding back against the propodus.

Length, from tip of rostrum to posterior margin of third abdominal segment (largest example), 21 mm.; rostrum, 7 mm.

Hab.—New South Wales: Port Jackson (Stimpson). South Australia: St. Vincent Gulf (W. H. Baker and H. M. Hale), St. Francis Island (Sir Joseph Verco), Ardrossan (Cadd). Western Australia: Geographe Bay, 15-16 fms. (Sir Joseph Verco).

The spines on the lower side of the rostrum vary in number, but usually three are present; in a series of fifty specimens from St. Vincent Gulf, three have two spines below (as described by Stimpson), thirty-one have three, fifteen have four, and one example has five. Specimens taken at Nuyts Archipelago represent a simple variety:—

Rostrum at least one-fourth longer than carapace and about twice as long as the antennular peduncles; almost straight anteriorly, curving gently upwards from the neighbourhood of the first inferior spine; with a single superior spine, near base, and three, four, or five spines below, regularly decreasing in size anteriorly; the first is placed at, or a little in advance of the posterior third of the rostrum, the last is minute, subapical. Antennular flagella subequal, extending as far as, or slightly beyond tip of rostrum.

Length (largest example), 23 mm.; rostrum, 8·7 mm.

Hab.—South Australia: Nuyts Archipelago (dredged from "Conqueror") and Spencer Gulf.

PANDALUS (PARAPANDALUS) LEPTORHYNCHUS, var. *gibber*, var. nov.

Pl. iv., figs. 6, 7.

♀. Rostrum a little longer than carapace, with a single dorsal spine near base and another distinct inferior spine near apex. Carapace with a spine behind base of rostrum. Third segment of abdomen strongly compressed dorsally, and elevated above the level of the preceding segments. Telson longer than sixth abdominal segment. Legs moderately stout; carpos of the second pair three-jointed, the second and third joints together one-half longer than the first, which is about one-third longer than the third joint.

Length, 31 mm.; rostrum, 10·5 mm. (S. Austr. Mus., Reg. No., C. 205).

Hab.—St. Vincent Gulf.

Two much damaged ovigerous females are in the collection. The characters given above, together with the figures, suffice to separate this variety.

Family PALAEMONIDAE.

LEANDER INTERMEDIUS, Stimpson.

Dredged from "Conqueror," 3-4 fms.

LEANDER SERENUS, Heller.

Hab.—Flinders and Pearson Islands; in rock pools.

Apparently no species of *Leander* has been previously noted from South Australia; the two forms recorded above are common.

LEANDER LITOREUS, McCulloch.

Hab.—Flinders Island; in rock pools.

Three specimens were taken in company with *L. serenus*. These two species have also been found associated at Glenelg, South Australia; both seem to frequent rock pools rather than the open sea and reefs, as does *L. intermedius*.

Suborder REPTANTIA.

Tribe ANOMURA.

Family CALLIANASSIDAE.

UPOGEBIA (GEBIOPSIS) BOWERBANKII, Miers.

Hab.—Smoky Bay; several small examples.

Family PAGURIDAE.

CLIBANARIUS STRIGIMANUS, White.

Hab.—Flinders Island; in a rock pool.

A large specimen from a *Fusus* shell. Soon after capture this example vacated its retreat and crawled about unprotected The species was also taken by Sir Joseph Verco, in the Great Australian Bight, many years ago

PAGURISTES SULCATUS, Baker

Dredged from "Conqueror," 3-4 fms

Tribe BRACHYURA

Family DROMIIDAE.

CRYPTODROMIA OCTODENTATA, Haswell

A specimen dredged from the "Conqueror" bears a sponge which is eight times the weight of the crustacean. This common species was on several occasions taken by the Federal trawler "Endeavour" in South Australian waters, one female being trawled "Fifteen miles south of St. Francis Isle, South Australia, 30 fms."

The two following Dromiid crabs were also taken by the "Endeavour" at the same locality:—

Dromidiopsis excavata, Stimpson. *Petalomera depressa*, Baker.

Family XANTHIIDAE.

PILUMNUS TOMENTOSUS, Latreille.

Dredged from "Conqueror," 3-4 fms.

OZIUS TRUNCATUS, Milne-Edwards.

Flinders Island; under stones on beach.

Family GONEPLACIDAE.

LITOCHEIRA BISPINOSA, Kinahan.

Dredged from "Conqueror," 3-4 fms.

This common little species has been recorded from St. Vincent Gulf by McCulloch.

Family GRAPSIDAE.

LEPTOGRAPSUS VARIEGATUS, Fabricius.

Dredged from "Conqueror," 3-4 fms., and Flinders Island, in rock pools.

Examples from the island are of dark-grey colouration, matching that of the rocks from amongst which they were taken. In a specimen dredged away from shore, the predominant colour is dark red.

BRACHYNOTUS OCTODENTATUS, Milne-Edwards.

Hab.—Pearson and Flinders Islands; plentiful on coasts.

Mr. Waite notes that on Flinders Island "specimens were taken from a well, containing brackish water, used at the camp for the first meal only. The crabs

must have fallen in, and they could not possibly escape. Whether they bred in the well, or whether the numbers are maintained by new arrivals, it is not possible to say."

CYCLOGRAPSUS AUDOUINII, Milne-Edwards.

Dredged from "Conqueror," 3-4 fms., and Flinders Island, under stones

Family INACHIDAE.

NAXIA AURITA, Latreille.

Dredged from "Conqueror," 3-4 fms.

SCHIZOPHRYS ASPERA, Milne-Edwards.

Dredged from "Conqueror," 3-4 fms.

Family HYMENOSOMATIDAE.

ELAMENA (TRIGONOPLAX) UNGUIFORMIS, De Haan, var. *longirostris*, McCulloch (text fig. 1).

Elamena (Trigonoplax) unguiformis, De Haan, var. *longirostris*, McCull, Rec Austr Mus, vii, 1908, p 59, pl xii., fig. 3, Kemp, Rec. Ind. Mus, xiii., 1917, p 278

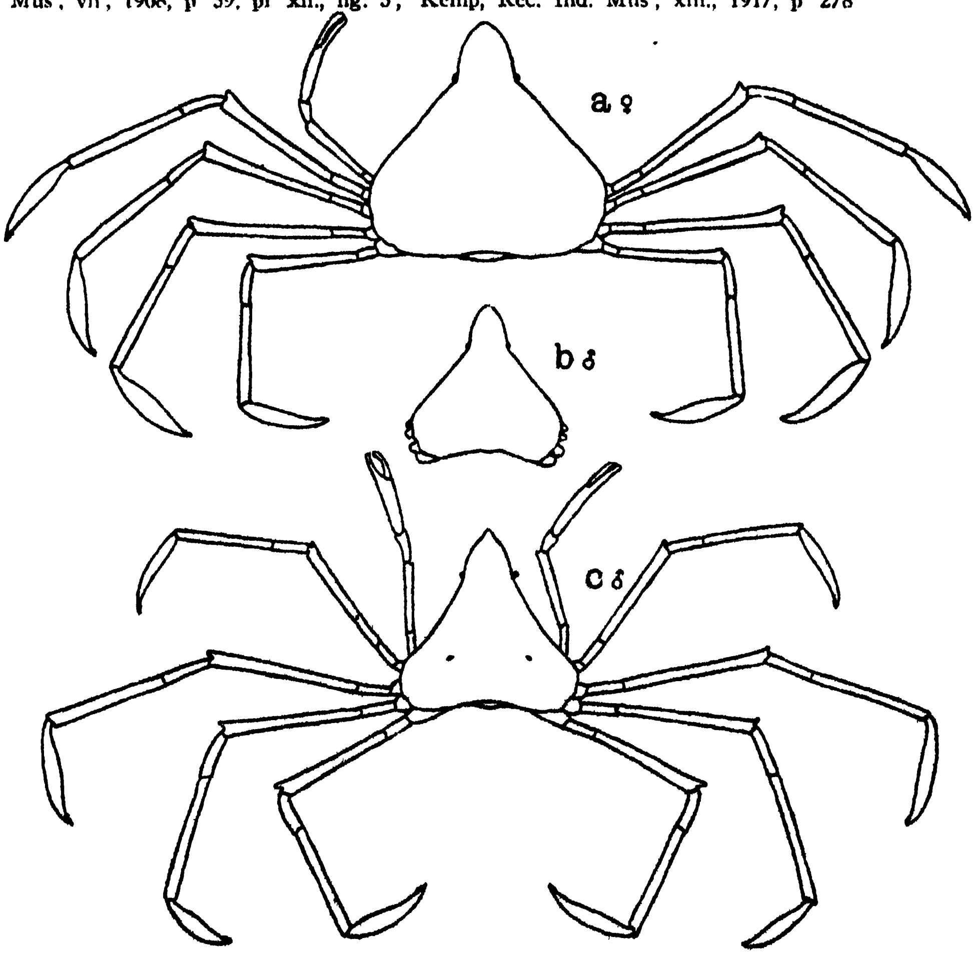

Fig. 1.

Elamena (Trigonoplax) unguiformis, var. *longirostris*; South Australian specimens.

Four males and four females from South Australia differ from the specimen figured by McCulloch in having the antero-lateral margins of the carapace almost straight and the sides of the rostrum evenly convex and converging regularly from base to apex (fig. 1, *a* and *b*). A ninth example has the sides of the carapace a little concave and the margin of the rostrum sinuate, thus more nearly approaching McCulloch's figure. In this last specimen the legs are relatively longer than in the others (fig. 1, *c*).

A single male was dredged from the "Conqueror," 3-4 fms

Hab.—Victoria: Port Phillip (McCulloch, type loc.). South Australia: St. Vincent Gulf, Kangaroo Island (north coast), and Nuyts Archipelago.

ISOPODA.

Tribe FLABELLIFERA.

Family CIROLANIDAE.

Cirolana wood jonesi, n. sp.

Pl. v, text fig. 2.

Form moderately slender, very convex; a little variable in width, the greatest breadth two and two-thirds to almost three in the length.

Head wider than long, its medial length a little less than that of first thoracic segment. Eyes black, in lateral view longer than deep; upper margin almost straight; facets rather large, six to seven in a longitudinal series. First antennae extending to about middle of ultimate peduncular joint of second antennae; second antennae with third, fourth, and fifth peduncular articles subequal in length; flagellum variable in length, reaching back nearly to posterior margin of first thoracic segment, or a little beyond it, usually composed of from eighteen to twenty articles, but occasionally as many as twenty-seven are present. Frontal lamina about four times longer than greatest width, distinctly widened at anterior third, narrowed behind this, and again slightly dilated at posterior end; the front end not visible from above. Clypeus less than half as long as frontal lamina, and considerably shorter than the labrum; convex, with lateral margins elevated. Maxilliped with seven articles. Mandible with the three teeth of cutting part usually very distinct; occasionally the middle tooth is obsolete; palp composed of three articles. First thoracic segment much longer than any of the others, which are more or less subequal in length.

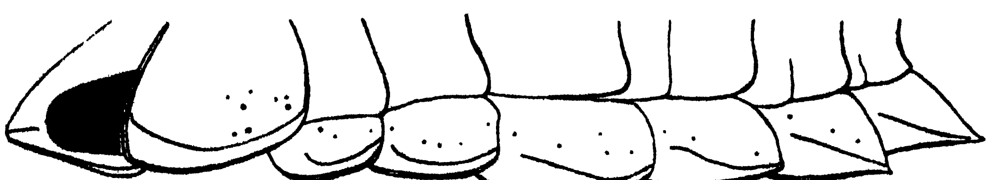

Fig. 2.
Thoracic epimera of *Cirolana wood jonesi.*

Epimera of second to seventh segments each with an oblique furrow (in addition to the obscure submarginal furrow) arising near the infero-posterior angle and curving forwards towards (but not reaching to) the middle of the posterior margin of the preceding epimeron; the furrow of the seventh epimeron does not reach to the posterior angle in most examples, but is occasionally obscurely continued to it. The second joint of the legs becomes increasingly expanded posteriorly, that of the first leg being barely more than three-eights as wide

as the seventh, and widest. Seventh leg with the second joint much expanded, its greatest width being almost three-fourths of the length, and with lateral margins and inferior median ridge set with long, plumose hairs; third joint longer than any of the following joints; fourth slightly longer than fifth and a little shorter than the sixth joint. Lateral margins of telsonic segment convex, without apparent spines. Uropods moderately slender; endopod about two and one-third times longer than wide, reaching slightly beyond termination of abdomen, not notched near end of outer margin; exopod shorter than endopod, four times longer than broad.

Colour (during life), whitish, more or less suffused with red.

Length (largest example), 18 mm. (S. Austr. Mus., Reg. No., C. 228).

Hab.—South Australia: Elliston (Nuyts Archipelago Exped.), St. Vincent Gulf (H. Collyer and others), Beachport, 3-4 fms. (H. M. Hale).

The above description is based upon a series taken from the body cavity of a Port Jackson shark *(Heterodontus phillipi)* collected by Mr. Collyer; there are also before me examples taken from a seven-gilled shark *(Notidanus indicus).* The Elliston specimens are mostly of small size and were captured on bait when line fishing. The species was dredged at Beachport and found buried in wet sand at the water's edge near the Outer Harbour.

As mentioned above, the flagellum of the second antennae varies in length and in the number of articles of which it is composed; the variation is not according to age. *C. wood jonesi* somewhat resembles *C. borealis,* Lilljeborg, and is still more closely allied to *C. gallica,* Hansen, from France. It may be distinguished from the last-named species by the straighter upper margin of the eye and by the less oblique furrows of the epimera of the fourth to sixth thoracic segments; in *C. gallica* each of these furrows is directed forwards and upwards towards the middle of the thoracic segment above. The presence of the oblique furrows at once separates *C. wood jonesi* from *C. borealis.*

Of the Australian species it, in some respects, approaches *C. tenuistylis,* Miers,[1] which is rather briefly described; according to Miers' figure, however, the eye of that species is subcircular in lateral view, the frontal lamina is of different shape, and there are no oblique furrows on the thoracic epimera.

Family SEROLIDAE.

The following species were dredged "off St. Francis Island, 6-13 fms.," y Sir Joseph Verco, and were recorded by Dr. Chas. Chilton[2]:—*Serolis tuberculata,* Grube; *S. longicaudatus,* Beddard; *S. minuta,* Beddard.

EXPLANATION OF PLATES IV. AND V.

PLATE IV.

Fig. 1. *Pandalus (Parapandalus) leptorhynchus;* female, St. Vincent Gulf, (enlarged 2½ diams.).

„ 2. Dorsal view of cephalothorax of same (enlarged 5 diams.).

„ 3. Carapace of *P. leptorhynchus,* var.; female, Nuyts Archipelago (enlarged 3 diams.).

„ 4. Dorsal view of cephalathorax of same (enlarged 5 diams.).

„ 5. Second leg of *P. leptorhynchus* (enlarged 14 diams.).

„ 6. *P. leptorhynchus,* var. *gibber;* female, St. Vincent Gulf (enlarged 3 diams.).

„ 7. Second leg of same (enlarged 14 diams.).

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(1) Miers, Zool., "Alert," 1884, p. 303, pl. xxxiii., fig. *b.*

(2) Chilton, Trans. Roy. Soc. S. Austr., xli., 1917, pp. 393-397.

Plate V.

Cirolana wood jonesi.

Fig. 1. Lateral view.
„ 2. Dorsal view.
„ 3. Ventral view of head (maxillipeds removed).
„ 4. Front view of same to show frontal lamina
„ 5. First antenna.
„ 6. Second antenna.
„ 7. Mandible.
„ 8. Distal part of molar process of mandible.
„ 9. First maxilla.
„ 10. Second maxilla.
„ 11. Maxilliped.
„ 12. First leg.
„ 13. Seventh leg.
„ 14. Telsonic segment and uropods.
„ 15. Right pleopod of second pair of male.

Figs. 1 and 2, enlarged 4 diams.; fig. 8, enlarged 100 diams.; figs. 12, 13, and 15, enlarged 10 diams.; remainder of figs., enlarged 20 diams.

AN ACCOUNT OF A HITHERTO UNRECORDED TYPE OF ABORIGINAL STONE OBJECT.

By T. D. Campbell, D.D Sc.

[Read June 12, 1924.]

The following notes contain a short description of what appears to be a hitherto unrecorded type of native stone object. Briefly, the circumstances of the discovery of these objects are as follow:—A very large native camping ground is situated in an area of blown sand dunes where Pedler's Creek reaches the coast, three miles south of Port Noarlunga, or about 24 miles from Adelaide. This site is an old one, and was probably occupied by natives belonging to what is popularly referred to as the Adelaide Tribe, but which is, according to J. J. East, more correctly known as the Winnaynie Tribe. The old camp site has proved a more or less profitable hunting ground for collectors of native stone implements for some considerable time. On a visit to this spot in March of this year, while searching for worked flakes, the writer's attention was attracted to a piece of slatey material, which appeared to have an artificial contour and unusual markings on it. The object had been broken, but the fragment was sufficiently complete to indicate that when intact, it was roughly kidney-shaped in outline, and the surfaces of the fragment were covered with incised markings, obviously a piece of aboriginal handiwork. A continued search was rewarded by the finding of another example of the same type. The lateness of the hour prevented further search on that occasion. A subsequent brief visit to the same site produced no further finds.

In the early part of April, the site was again visited in order to carry out a more careful and systematic search, and the writer is indebted to his friends, Messrs. A. Williamson and P. S. Hossfeld, for their enthusiastic assistance on the third examination of the site. Garden rakes were carefully used for disturbing the sand in the hope of revealing stones that had been buried in the drift. The search resulted in Mr. Hossfeld finding another undoubted example of the same type of object, and the writer was fortunate enough to recover three small fragments belonging to the broken specimen of his initial find.

A general description of this type is as follows:—All three examples have been fashioned from thin pieces of greenish-grey slate[1] about 5 mm. thick; all are roughly reniform in outline and very similar in dimensions. They show obvious indications of having been shaped into a definite form and rubbed to a requisite smoothness. Each possesses a large notch on its lower border which was deliberately cut out, as is shown by the smoothing down of, and remaining scratches adjacent to, the edge of the notch. All have incised markings in varying degree of perfection and complication. Two, apparently either newer or less weathered specimens, still bear remains of a coating of red ochre. A detailed description of each example is here given.

No. 1 (fig. 1).—Fragment constituting a little more than half of what had been a rather well-contoured and symmetrical object. Smaller fragments found subsequently are also shown in position; the position of the detached portion is hypothetical, but it has been arrived at by a careful comparison of its

(1) Mr. P. Hossfeld informs me that these specimens are probably of phyllitic slate, with their surfaces sand polished, this material being fairly common in the Mount Lofty Ranges.

thickness relative to that of the major portion. Horizontal diameter, 92 mm.; vertical diameter, 60 mm. (estimated). Periphery well rounded and smoothed. Surface A presents incised markings thus: commencing at each outer corner are small cuts, about 3 mm. long, at irregular intervals around the periphery; the main area shows one complete and two incomplete rows of incised vertical marks, varying from 3 to 6 mm. Other faint irregularly-placed incisions appear to bear little relation to the inscriptive markings and were probably caused in smoothing down the surface with some harder material. Along the border of the large notch are long scratches, undoubtedly made during the fashioning of the notch. This surface, and also the surface of the fractured edge, bear a

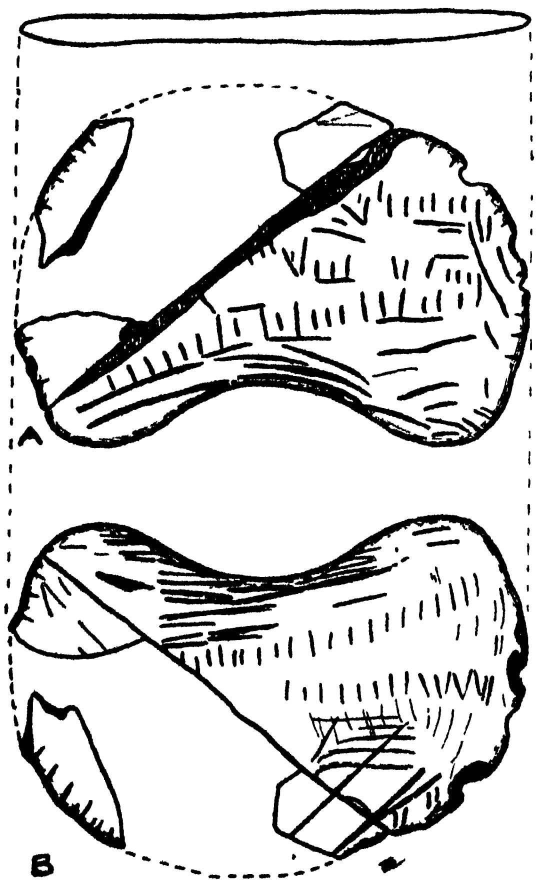


Fig. 1. Specimen No. 1. ×[illegible].

"patinated" appearance, no doubt due to weather and the action of blown sand, and therefore not a true patina; this polishing action has tended to the partial obliteration of the surface markings. Surface B also presents the peripheral markings and portions of two rows of vertical incisions. Well-marked scratches on the border of the notch are probably incidental to its formation. Near the border, opposite to the notch, are several rather deeply-cut lines in a slanting position, and two pairs of small, well-marked, vertical cuts adjacent to them. This surface has obviously not been exposed to weather so much as has Surface A.

No. 2 (fig. 2).—This example is complete and is more nearly circular in outline than No. 1, but it has not the basal notch so well developed; also its border has not been finished so smoothly, for in places it plainly shows the chipping carried out to obtain the desired outline. In size it is 92 mm. in its horizontal and 66 mm. in its vertical diameter. Both its surfaces bear faint traces of red ochre with which they had been rubbed. Surface A presents two strikingly well-cut "arrow" figures which "point" in a slanting direction downwards to the left side of the notch; the upper one measures 14 mm. and the lower 9 mm. in length. Near the left side are two slightly converging vertical lines about 10 mm. in length. On the lower part of the surface are a

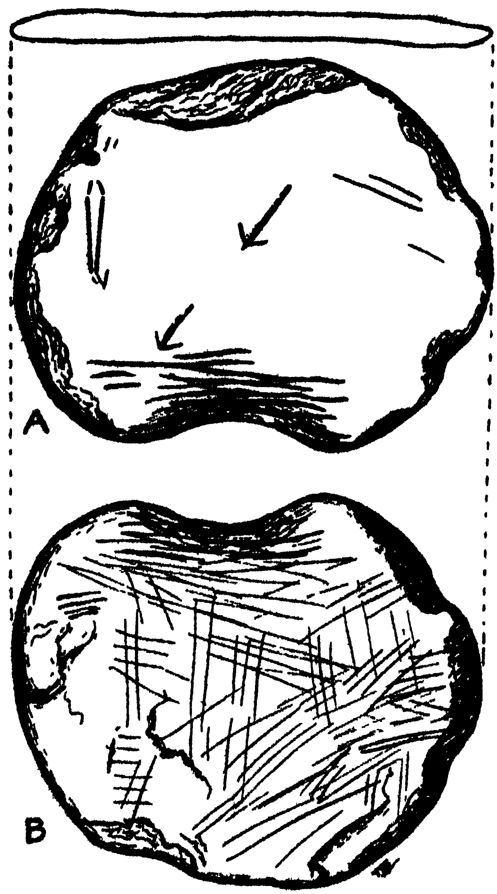


Fig. 2. Specimen No. 2. ×½.

number of more or less parallel horizontal lines which merge with the scratches associated with the notch formation. Red ochre is present, especially on the left side of this surface. Surface B is rougher than A, and is covered with many scratches occurring in a variety of directions; these are probably due either to a haphazard decoration of the whole surface or to an attempt to smooth down the surface with some harder piece of stone. The whole surface bears remains of a red ochreous coating.

No. 3 (fig. 3).—This specimen exhibits poorer execution than the other examples. A small fragment is missing from one side of the notch, the notch

itself being broad and shallow. In size this specimen measures 90 mm. in horizontal and 61 mm. in vertical diameter. Both surfaces present "steps" of varying size at their periphery, caused by the shaping up of the object.

Surface A, on its right side, has two deeply-incised vertical lines about 20 mm. in length, and near them, two shorter and fainter lines; also nearer the edge on the same side are two groups, one of four and the other of three lines. On the left side near the fractured edge are a number of irregular scratches, while just above the notch are three broad but scarcely discernible cuts. The border of the notch shows many fine scratches. A large shallow

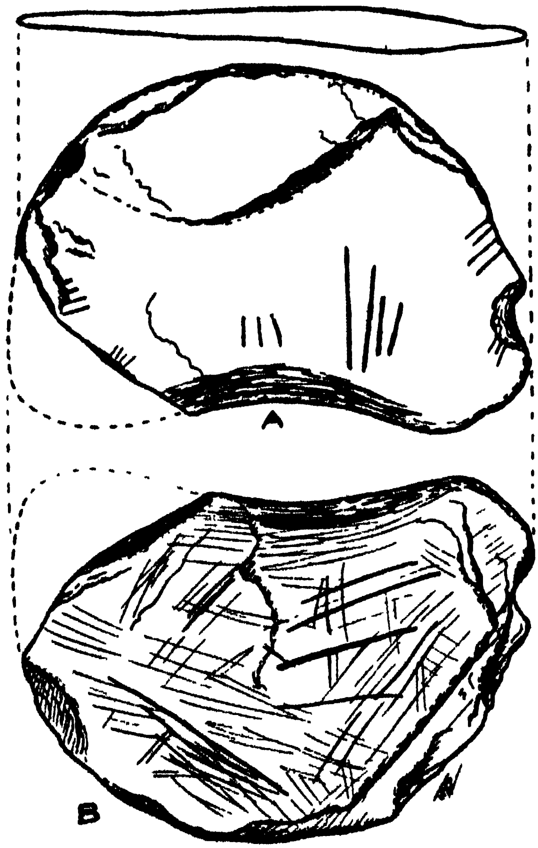


Fig. 3. Specimen No. 3. ×1

"step" occupies most of the upper part of this surface. Surface B presents deep "stepping" on its lower and right borders, due to attempts at shaping the object, and practically the whole surface is irregularly scored in a manner similar to Surface B of No. 2. It also bears the remains of an ochreous coating.

Probable Purpose of the Objects and Significance of their Markings.

As the accounts of the natives who occupied the southern parts of this State contain but little information concerning material culture, not much assistance is forthcoming from the literature. Therefore, any suggestion as to the purpose of these objects must be based on conjecture and on analogy derived from a study of the more northerly tribes.

The possibility of their being a form of implement can be readily dismissed, as they are of a material and shape which would serve no utilitarian purpose. Of the smaller types of objects which bear scratches and markings, there are message sticks, and the sacred and ceremonial objects. Those for the conveyance of messages apparently always took the form of a piece of wood, and probably have no relation whatsoever to these reniform slates. On the other hand, considering them as a type of ceremonial or sacred object, we may find some evidence which points to such being their correct designation.

Comparison may be made with the stone Churinga or totemic objects of the Central tribes of this continent; the parallel features are as follow: they are made from a thin palette of stone, and present obvious indications of having been shaped into a definite form; they have incised markings and show the application of red ochre.

As regards the form of the present specimens, they are thinned down and shaped to a definite outline, as are the stone Churinga of the Central tribes, and although the reniform contour of the former differs from the usual oval or pear shape of the latter, this does not totally destroy their likeness, but renders it the more interesting. In the objects from Central Australia, the incisions take the form of quite ornate designs, executed chiefly in concentric figures and curved lines, or groups of straight lines, or markings imitative of natural objects; while in the present type the incised decoration of the stones is comparatively crude and asymmetrical. However, there seem to be reasons for considering material culture at a lower standing among the natives in the southern parts of the State than among those of the central and northern areas of the continent; and this, together with the possibility of the totemic system being relatively less advanced among the former, may account for the comparative crudity of the workmanship. The coating of these objects with red ochre affords a parallel with the more northerly specimens on which, particularly the flat stone Churinga, its occurrence is fairly frequent.

The nature of the incised markings shows some impressive points of similarity. Probably the most striking and readily interpretable are the "arrow" figures on Surface A of No. 2. These are identical with the figures present on some Churingas which are attributed to natives of an emu totem in the Central tribes; these "arrow" figures represent the footprints of the emu, or some animal like the kangaroo or rat kangaroo. Therefore it seems not unlikely that Specimen No. 2 was a sacred object of some native belonging to a kangaroo or emu totem in this southern vicinity. Again, the small peripheral markings, so well shown on the border of Specimen No. 1, form a very similar method of decoration to that appearing on some of the Churingas of the Central tribes. The rows of vertical lines and the lack of definition and figure design in other of the markings on our present examples present a problem incapable of easy interpretation. However, crude and obscure as these markings may appear to us, they no doubt had a very definite and important meaning for those who were conversant with these objects. The general distribution and varied direction of the scratches on Surface B of both Nos. 2 and 3 seem to suggest that they formed a general decorative scheme of the whole surface without having any special meaning.

Further finds and more intensive comparative study would no doubt completely solve the problem as to the nature and purpose of these incised slates. For the present, the recording of their occurrence seems to be justified, in that it at least adds a small contribution to our present sparse fund of information on the material culture of the natives who inhabited the southern parts of this State, and also places on record the finding of what is probably another form of ceremonial object.

POUCH EMBRYOS OF MARSUPIALS.

No. 8.—DENDROLAGUS MATSCHIEI.

By F. Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read June 12, 1924.]

For the opportunity of examining the pouch embryo of this rare and interesting tree-wallaby I am indebted to Mr. A. S. Le Souef, of Taronga Park, who very kindly placed at my disposal a specimen in an extremely good state of preservation. Since the genus *Dendrolagus* presents so many interesting problems in phylogenetic readaptation, the examination of the young animal is a matter of some importance. Two alternatives might be considered possible. We might discover that the young animal was more phalangerine in its early stages and that its macropine characters were merely superficial, or we might find that the earlier stages showed it to be truly macropine and its phalangerine characters were merely convergent. The animal might possibly be a macropus-like phalanger, or a phalanger-like macropus. It might be an old-established arboreal animal convergently somewhat like a kangaroo, or it might be a real

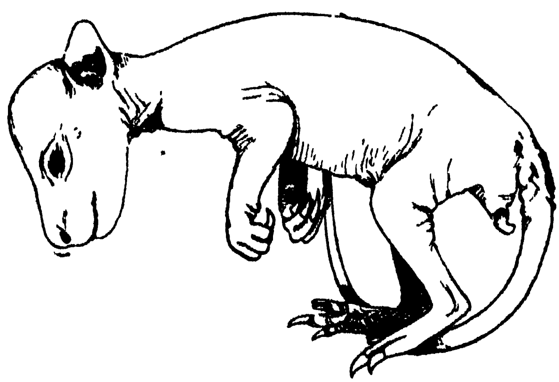


Fig. 1.
Dendrolagus matschiei.
General form and proportions of pouch embryo. Half natural size.

terrestrial kangaroo reacquiring arboreal habits after a terrestrial apprenticeship. The specimen examined is a male, 125 mm. R.V. measurement, with a total head and body length of 195 mm., and a tail length of 109 mm. Although hair is just beginning to appear upon the general surface of the body, it is, unfortunately, not sufficiently developed to permit of any ordered disposition of hair tracts being detected. Such sensory vibrissae as are developed are fully erupted and pigmented.

The general form of the animal is very remarkable (see fig. 1), for the mixture of phalangerine proportions and macropine structure results in the production of a very strange type of animal. The excessively large fore limbs are very different in appearance from the slender and under-developed appendages

of the typical macropines. The hind limbs are even more remarkable, for with the general macropine outline of structure, they are extremely short and stout and very unlike the typical elongated legs and feet of the normal kangaroos The general build appears to be extremely clumsy, and were the habits of the adult to be unknown, the naked pouch young would present a very real problem.

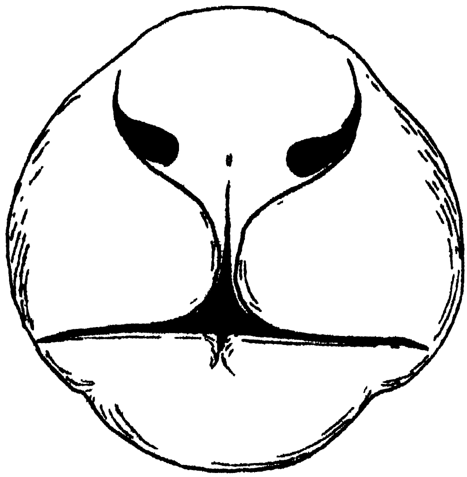


Fig 2
Dendrolagus matschiei
The form of the rhinarium Four times natural size

Fig 3
Dendrolagus matschiei
Characters of the auricle of the left side. Four times natural size

The head is, in all its main features, typical of the normal kangaroos. The rhinarium (see fig 2) is not yet completely differentiated, for it is impossible to determine from this young animal exactly what area of the muzzle will be hairless and what hairy. In its form, however, the rhinarium is typically macropine; so, too, is the very definite mid-mandibular cleft which here, though not very deep, is perfectly clearly defined

Fig. 4.
Dendrolagus matschiei.
Outline of the head to show the disposition of the facial vibrissae Natural size.

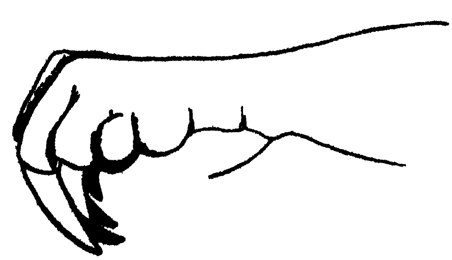


Fig. 5.
Dendrolagus matschiei.
The well-developed ulnar carpal papilla and single vibrissa. Twice natural size.

In the auricle, the processes antihelicis is in the form usual in the kangaroos (see fig. 3), and it presents no outstanding features by which it could be distinguished from that of *M. agilis* or *M. eugenii* embryos as the same stage of development. The processus is well defined but not greatly raised; and deeper in the auricle is a second, larger, but more irregular, derivative of the antihelix.

The vibrissae and papillae are not particularly well developed. Upon the face (see fig. 4) the supraorbital papilla gives rise to four curved vibrissae; the genal papilla is partially subdivided into an upper papilla giving rise to two vibrissae and a lower papilla giving rise to only one.

The mysticial set is poorly developed, the papillae being better developed than the vibrissae, which spring from them. They are arranged, in this specimen, in four rows, with the recognisable papillae in the order 1, 3, 3, 4. Apart from the mysticial vibrissae proper, the upper lip is fringed by short, curved, and somewhat stiff hairs. In the same way, the point of the chin gives rise

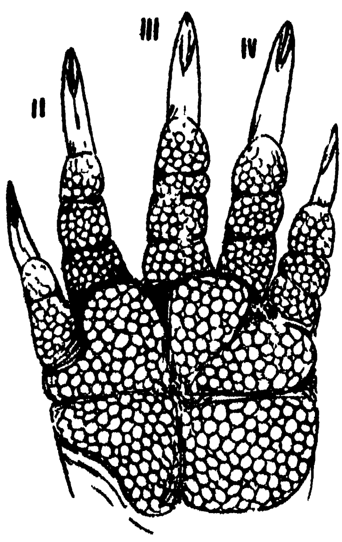


Fig. 6.
Dendrolagus matschiei.
Palmar surface of left manus. Three times natural size.

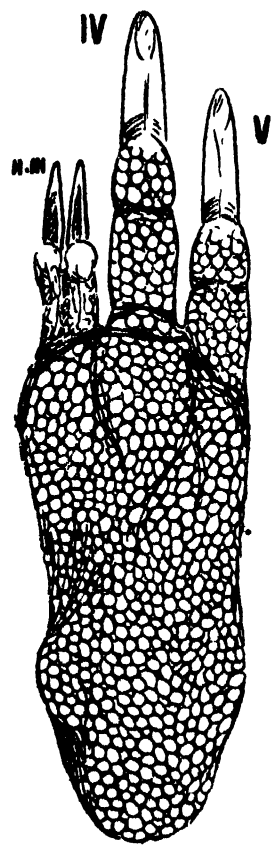


Fig. 7.
Dendrolagus matschiei.
Plantar surface of left pes. Three times natural size.

to numerous curved bristle hairs which do not arise in connection with papillae In addition, the lower jaw carries two well-defined papillae upon either side of the middle line. These two low mandibular papillae give rise to two vibrissae each, and the hinder is about as far distal as the angle of the mouth. The ulnar carpal papilla is well developed and, as in the typical wallabies, only a single vibrissa springs from it (see fig. 5). The manus is at once distinguished for its relatively enormous size and for the sturdiness of the limb upon which it is borne. The claws are long and robust and are all about equally curved. The digits are without defined apical pads, and are coarsely granulated over the whole

of their palmar surface. The palm is evenly granulated. The outlines of five ill-defined pads are distinguishable and the pads present are interdigital pads 1 and 2 fused, and 3 and 4 separate, with large thenar and hypothenar pads. The digital formula is $3 > 4 > 2 > 5 > 1$, the small size of the first digit being a notable feature (see fig. 6). The pes is very remarkable and agrees in most respects with that of the adult of *D. ursinus* figured by Bensley. The shortness of its digits is particularly striking and the total length of the pes is only about three times its breadth, whereas, in an embryo of *Macropus agilis* of the same size the proportion is eight to one. The first digit is entirely wanting, the syndactylous elements are well developed, the typically dominant 4th and 5th digits being very short when judged by normal macropine standards.

The claws of the 4th and 5th digits are somewhat curved, but it is to be noted that their curvature does not exceed that typical of those of the terrestrial Macropodidae at this stage. The 4th and 5th digits are coarsely granulated The curious padded sole has no well-defined pads, but presents the appearance of a cushion, studded over with circular elevated granulations (see fig. 7).

It is, therefore, clear that *Dendrolagus,* although it has somewhat phalangerine proportions, has typical macropine structure. Its phylogenetic terrestrial apprenticeship has shaped and modified all its parts, its present arboreal radiation is merely altering the relative proportions of these modified parts. It certainly shows how the best arboreal use may be made of terrestrial saltatory members, but it also demonstrates how impossible it is to re-beget a primitive arboreal phalanger manus and pes from those members when once they have modified their primitive structure in harmony with the demands of the specialised function of terrestrial leaping.

In the adult *Dendrolagus* the claws of the dominant digits of the pes are curved, thus affording a great distinction from the almost straight claws of the typical wallabies; but this curvature is merely a retention of the condition which is present in the young of all wallabies.

It is rather remarkable that the pollex is no better, but even rather worse, developed than it is in the typical kangaroos. There seems to be no recall for a pollex or hallux that has undergone phylogenetic reduction.

ON THE DISCOVERY OF SUPPOSED ABORIGINAL REMAINS NEAR CORNWALL, TASMANIA.

By Robert Pulleine, M.B., M.Ch.

[Read June 12, 1924.]

Plates VI. to IX.

In the British Museum there is an object which is figured in Ling Roth's "Aborigines of Tasmania," Ed. 2, p. 64, and there described as a "Tasmanian skin bag supposed to contain ashes of human bones." What is undoubtedly another example of a similar object was found near Cornwall by a man, named Bradbury, early in 1920.

The circumstances of the discovery were as follows:—Mr. Bradbury was walking along the base of the escarpment of the Mount Nicholas Range, near the village of Cornwall, when he found a deep cleft beneath an overhanging sandstone rock. On the floor of the cleft he discovered a skin bag covered with stringy bark and held down by two stones. On examining the contents of the bag he found it to contain two dried hands, five bones, two shells, and some skin and other matter which resembled dried viscera. Bradbury took the bag and contents to the Police Officer, at St. Mary's, and an inquest was held on them at the Court House at Fingal, where the medical witness testified that they were human remains of old but uncertain age.

In August, 1923, I was asked to inspect them in Melbourne, whither they had been removed, and in November, 1923, I took charge of them, intending to investigate the circumstances later. In April, 1924, I was able to locate Mr. Bradbury, the discoverer of the objects, at his home at St Mary's, and together we motored up the mountain side to the village of Cornwall and ascended the mountain to the escarpment, following which we reached the cleft where the discovery was made.

The Locality.

The Mount Nicholas Range consists of coal-measures (Trias Jura) on a base of Permo-Carboniferous age, the coal being overlaid by a peculiar felspathoid sandstone of the same age, and this, again, capped by diabase (? cretaceous). This range is close to the town of St. Mary's, within a few miles of the east coast, and lies in the triangle formed by the South Esk and Break o' Day rivers. The range is thickly timbered with *Eucalyptus* and there is a dense undergrowth in which *Pomaderris*, of two or three species, predominates.

To reach the locality of the discovery we climbed from the village on to the mine track, and walking westward along the tram lines went upwards through the bush until the sandstone escarpment was reached. Climbing along this, to the westward, the spot was pointed out by Mr. Bradbury. Here I found the stones and bark on the floor of the ledge where they had been left when the bag and contents were removed in 1923.

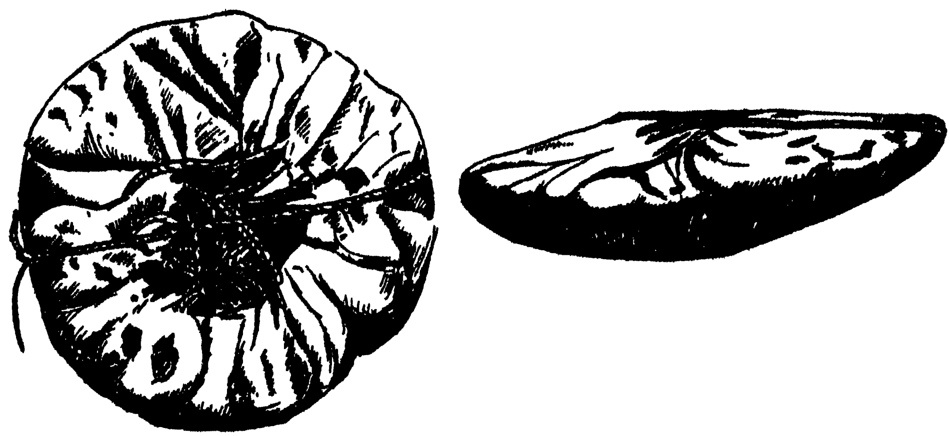
The photograph, reproduced as pl. vi., was taken next morning, and gives a good idea of the site. As seen from the place from which the photograph was taken, the essential points are a sandstone roof, overhanging the cleft by about 6 feet, and a cleft in the rock. The cleft itself, about 4 feet long, as measured on the floor, has a height of less than a foot in front, and a depth of about 2 feet 6 inches at the inner extremity where the roof and floor meet. The floor was composed of perfectly dry rubbly-sandstone on which the bark and

stones were resting, and below the front edge the cliff dropped vertically for 4 feet 6 inches to a ledge 2 feet wide, below which the sandstone formed a vertical wall, 12 feet high, terminating on the wooded slope below the base of the escarpment.

These details are given to show the peculiar conditions which must have led to the preservation of the objects in question:—1. A perfectly dry, deep cleft, facing southwards, overhung several feet by a heavy sandstone roof. 2. Its protection from below by a high, vertical, sandstone wall. The first condition would ensure freedom from moisture in all weathers, the second absolute protection from marauding animals; besides these, and most important of all, protection from bush fires was assured.

The Bag and Contents.

The Bag.—This is composed of a vegetable substance, origin unknown, which superficially has the appearance of partially tanned leather. Professor Robertson, of the Adelaide University, on the basis of the absence of any protein reaction, states that it cannot be of leather or any other animal tissue. The largest fragment of the bag is 14×9 inches, and from the arrangement of the slits at the side is, probably, only a half, or a third, of its original size. Two other pieces of the same material, much curled up, may be assumed to be part of the original bag.



Tasmanian skin bag, top and side view, supposed to contain ashes of human bones. The flat appearance is probably due to packing. Diam., 7½ inches. Brit. Mus. Redrawn from Ling Roth's "Aborigines of Tasmania," p. 64.

There is a ragged hole, 2½ inches in diameter, 2 inches from the margin of the large piece, and on the margin are the holes formed by a series of slits, the number and extent of which are well shown in the photograph. None of the string or cord used for drawing the bag together was recovered.

The Hands.—The right hand, slender, measures 6½ inches from the carpus to the end of the middle finger, the palm and dorsum are covered with skin, some of which is still black; a mass of flexor tendons is still attached. The two terminal joints of the little finger are missing.

The left hand has three strips of the skin of the arm removed with it, which are attached to the base of the thumb. A long piece of skin, with the two terminal phalanges of the little finger, was separate from the rest and is shown *in situ* in the plate but associated with the wrong hand.

On both sides the carpal bones were removed with the hands and remain *in situ*.

The skin covering the hands is, in part, still pigmented, and a histological examination by Mr. William Fuller, Lecturer on Histology at the Adelaide Medical School, shows that the pigment situated in the deep cells of the Malpighian layer occurs as in other coloured races. The nails are missing and the skin, in part, removed by insect activity. On the whole, however, the preservation is fairly good and the hands are those of an adult.

The Bones.—These are the right and left humerus, the right radius, and the right and left ulna.

As seen in the plate, portions of periosteum, capsular ligaments, and interossens membranes are still attached to the various bones, and the dried cartilage of the articular surface is still *in situ* and in a relatively fresh condition. Apart from some cuts on the cartilage on the heads of both humeri there are no marks on any of the bones.

The Shells.—Two valves, not paired, of *Pectunculus flabellatus,* a common bivalve of the Eastern Tasmanian littoral.

Other Contents.—A mass of tissues in a shrunken condition and much deteriorated by insect activity, appear to have been originally viscera. Nothing can with certainty be recognised, although two bodies have the appearance of dried kidneys.

COMMENT.

Although the package containing the bones, etc., is now in a fragmentary condition, the discoverer assured me that when he found it, it formed a bag. The contents were arranged as follows:—One hand on top, then the bones, etc., and the second hand at the bottom.

We may assume that the handling it underwent from curious persons and in the course of a legal process was too much for its friable condition. We may, however, I think, be sure that the British Museum specimen and that in question are of the same nature. A third, probably, is still in the collection of the Royal College of Surgeons, as it formed part of the Barnard Davis collection acquired by that institution. This is referred to in the Supplement to the "Thesaurus Craniorium" (1494, p. 65): "The two femora and two ulnae with dried soft parts tied up in a little bag made of bass." Other specimens in this collection bear witness to the extent to which the wearing of human bones was carried, *vide:* 1487, the calvarium of a child; 1488, 1489, 1490, lower jaws provided with strings to suspend them round the neck; 1491, 1492, two specimens of tibiae prepared for suspension in the same manner; and 1493, a left radius prepared in the same manner for the same purpose. All these relics were collected by George Augustus Robinson, Protector of Aborigines, and were purchased after his decease.

Bonwick, in his "Daily Life of the Tasmanians," p. 10, says:—"So many skulls and limb bones were taken by the poor natives when they were exiled to the Straits (Flinders Island) that Captain Bateman told me that when he had forty with him in his vessel they had quite a bushel of old bones among them."

In Stokes' "Discoveries in Australia," vol. 2, p. 466, we read:—"When being conveyed to Flinders Island, Mr. Bateman, commanding the colonial brig 'Tamar,' described them as reconciled to their fate, though during the whole passage they sat on the vessel's bulwark, shaking little bags of human bones, apparently as a charm against the danger to which they felt exposed."

Ling Roth, "Aborigines of Tasmania," 2nd Ed., pp. 64 and 65, gives several extracts from Tasmanian authors referring to this matter.

The Tasmanian habit of wearing human bones as remembrances is exactly paralleled in the Andaman Islands: see Barnard Davis, "Supplement to Thesaurus Craniorium," p. 66:—1552, calvarium; 1574, adult lower jaw; 1575, adult lower jaw; 1762, prepared calvarium; all prepared with native cord to hang round the neck.

Davis remarks, *loc. cit.*, p. 67:—"These very curious objects worn by the Mincopies may really be said to be repetitions of the relics worn by the Tasmanian tribes described in a former page (1487-1493); there is no difference of any importance between them. In the Tasmanian maxillae the harder cord made of sinew is wrapped closely from one end of the jaw to the other. The Mincopies have been contented with securing the relic on each horizontal ramus by a short wrapping of vegetable cord, and they have, in addition, joined the strings of beads both to the calvarium and the jaw."

In consequence of the difference of the mode of attachment in the Tasmanian relics, when worn, the chin hangs downwards; in those of the Mincopies, the condyles hang downwards.

The finding of the hands in the parcel under consideration is the point of unique interest, and it is certain that if the discovery had been made on the Eastern Victorian side of Bass Strait, they would have been identified as the Bret Bret of the Kurnai. Whether dried hands were used as objects of magic amongst the Tasmanians we have no information, so it cannot be proved one way or the other.

Finally, it is of interest to note that a tribe in the Central Division of Papua wears dried hands either as mementos or for magical purposes, *vide* "Patrolling in Papua," by W. R. Humphries, A.R.M., with an Introduction by J. H. P. Murray, Lieutenant-Governor and Chief Judicial Officer of Papua, 1923. On p. 144 we read as follows:—"Arrived at village of Dunai-ia with Chief Kewawi. Some of them I noticed had thumb nails 3 and 4 inches long, hard as wood and curved like the toe of a Cassowary. I also noticed some of the men and women were wearing human hand and leg bones, and I tried to learn the significance of this custom, but on this point they were reticent. I understand though that the hands are dried by continued exposure to the sun, that no preservatives are used."

DESCRIPTION OF PLATES VI to IX.

Plate VI.

Sandstone escarpment of Mount Nicholas Range, showing observer with hand near spot where remains were discovered. Note overhanging rock with deep cleft and dense surrounding forest

Plate VII.

The remains of the bag, 14×9 in., showing the slits for lacing. Compare with text figure.

Plate VIII.

The hands. Note that by error the long strip of skin to which are attached the terminal phalanges of the little finger is shown on the wrong hand. Below are two valves of *Pectunculus*

Plate IX.

The arm bones. Right and left humerus; right radius; right and left ulna.

THE ECOLOGY OF THE EUCALYPTUS FORESTS OF THE MOUNT LOFTY RANGES (ADELAIDE DISTRICT), SOUTH AUSTRALIA.

By R. S. ADAMSON, M.A., B.Sc., Professor of Botany in the University of Cape Town, and

T. G. B. OSBORN, D.Sc., Professor of Botany in the University of Adelaide.

[Read November 8, 1923.]

PLATES X. TO XX.

CONTENTS.

I. INTRODUCTION.

The present paper is the result of our joint study of the ecology of the Mount Lofty Ranges during July-December, 1922, which was based upon the observations of one of us (T. G. B. O.) extending over a number of years

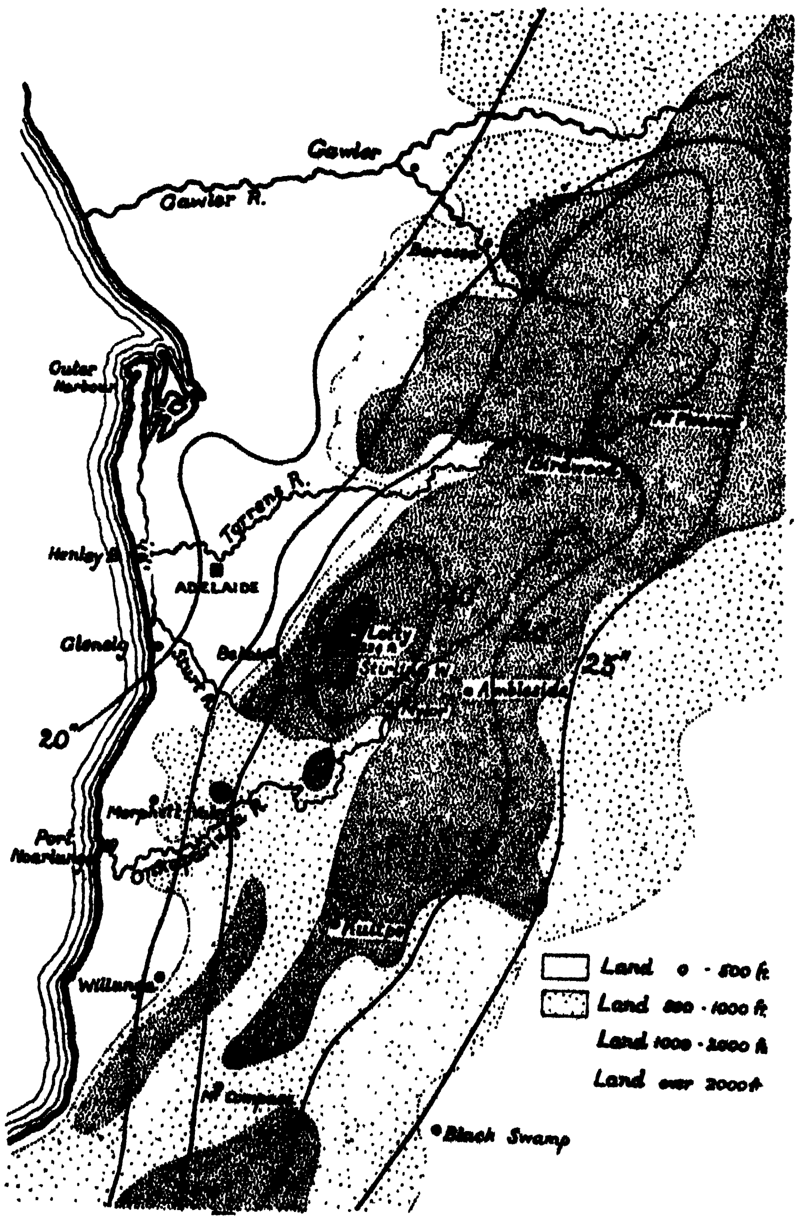


Fig. 1.

Diagrammatic sketch map of the Adelaide area showing isohyets and contours. Based on the rainfall map of South Australia issued by the Commonwealth Meteorological Bureau and a map issued in 1917 by the South Australian Dept. of Mines. True contour lines would be very irregular, especially for land over 2,000 feet.

previously. The district more especially considered is that lying within a 30-mile radius of Adelaide, but we have not limited ourselves to a consideration of that area when a knowledge of the vegetation in other parts of South Australia has been helpful for comparison.

It would not be possible to mention by name all those to whom we are indebted, jointly or severally, for hospitality or assistance by motor transport or in other ways during our work. Without such generous help the work could not have been accomplished, and we offer to all our sincere thanks. Finally, we wish to express our gratitude to the Royal Society of London for a grant towards the expenses of one of us (R. S. A.) in the field during a visit to Australia.

II. TOPOGRAPHIC AND PHYSIOGRAPHIC.

Adelaide stands on a comparatively level plain some six miles from the west coast of Gulf St. Vincent. Inland, to the east of the city, the Mount Lofty Range rises with rather steep slopes to a general height of about 1,500 feet, Mount Lofty, 2,334 feet, being the highest point (fig. 1). While it is possible to speak of a western face to the Mount Lofty Range near Adelaide, on the eastern side the summit generally extends as an elevated plateau which has a gradual fall towards the Murray River. Howchin, in a valuable series of papers (1910, 1913) has done much to explain the physiography of the region.

Briefly, the land is an old peneplain, the rivers of which had an approximately north-south drainage line. Subsequently the region was elevated and a series of step faults cut off the western part, forming a rift valley, now occupied in part by the Gulf St. Vincent. Along the shore of this, near to, and to the north of Adelaide an extensive plain has developed, partly coastal and partly flood in origin. The ancient north-south flow of the rivers has been altered by the elevation of the ground and the streams have been forced to cut new ways to the sea by turning to the west. While the upper reaches of such rivers as the Torrens and Onkaparinga are wide old valleys, in their lower courses they cross the ranges through steep-sided valleys or gorges to empty into the sea through mouths that readily silt up. The rivers themselves are in the nature of intermittent streams that attain the force of torrents during the wet season but almost cease to flow during the summer. The crest of the main Mount Lofty Range lies near to the western face. It consists of a complex of ridges separated by valleys, some of which have steep and rocky sides. These valleys form an intersecting series and run in varied directions. The ridges between may be broad and flat-topped or rather narrow, but for the most part the general outlines are smooth and somewhat rounded, not rugged.

Thirty miles to the south of Adelaide, is an extensive area of rolling hills and wide swampy valleys, the Mount Compass area. It lies rather beyond the area more especially considered by us, but the physiographic conditions are such that it is of great interest. Certain plant communities, but fragmentarily represented nearer Adelaide, are there developed on a large scale in the numerous swamps. The area is a district in which the older rocks are overlaid by more or less unconsolidated deposits due to glacial action in Permo-carboniferous times.

III. GEOLOGICAL AND EDAPHIC.

Geologically the Mount Lofty Ranges consist of a complex series of Cambrian and Pre-Cambrian rocks, often highly metamorphosed by subsequent earth movements. The relationships of the various beds is discussed by Howchin in the papers already cited (also 1904, 1906). As yet no detailed geological map of the area has been published. Even a superficial observation of the vegetation

is sufficient to show that many interesting correlations of the plant communities could be made were more geological data available. To an ecologist the geological work that has been published is most helpful because of the light that it has thrown on the physiography of the region and on the soils.

Soil surveys of the area are not available except for one district, that of Kuitpo forest. This, however, is typical of much of the main range that is occupied by stringybark forests of one type or another. The following data are taken from a bulletin written by Teale (1918). Eight soil types are recognised by him:—

I. Soils derived from quartz schists, quartz mica, and chloritic schists, felspathic schists of Pre-Cambrian age—

A. Yellowish, gravelly, clay loam found on table-top areas. This bears stunted scrub, chiefly *Eucalyptus cosmophylla*.

B. Gravelly loam, principally grey in colour, often stony on slopes. The stringybark timber is poor except in gullies.

II. Soils derived from sandy slates, phyllites, and quartzites of Cambrian age—

C. Gravelly sandy loam, chiefly grey in colour. Has good stringybark.

D. Red, gravelly, clay loam derived from slates and phyllites. Has good stringybark.

III. Tertiary to recent sands, gravels, clays, grits, boulder deposits, and alluviums—

E. Loose deep sands on which grow stringybark, manna gum, and *Casuarina*.

F. Light yellowish-red, sandy, clay loam. Vegetation similar to E.

G. Shallow, light-coloured, fine-textured, sandy clay on very tight clay. Stunted blue gum and pink gum in wet badly-drained areas.

H. Grey to dark-grey sandy loam, clay loam, and silt loam (alluvium), chiefly on valley floors. Typical red gum soil with occasional blue gums.

Our observations are in close agreement with those of Teale on the distribution of the native timber trees. Kuitpo Forest lies within the 30-inch isohyet. With less rainfall we find that blue gum forests develop on gravelly clay loams derived from slates and phyllites of Cambrian age (Teale's soil-type D). The differences in distribution of the trees on similar soil types but with different rainfalls bear out our main contention developed below. It is that the master factor in distribution of the forest types is climatic, but that as the junctions of different climates are necessarily broad in this region, edaphic factors may play an important part in determining the development of one or other forest type along the line of junction.

Teale notes that in all soil types, except the alluvial areas, ironstone deposits may develop. These may vary from loose concretionary gravels, through various degrees of ferrugenous change in slates or quartzites to the local development of aluminous and argillaceous limonite as a hard pan near the surface. These changes are the result of a superficial reaction developing under the climatic conditions obtaining here, specially the alternation of pronounced wet and dry seasons. They are comparable to the development of travertine limestone in calcareous areas. As will be seen below, we have found that these ironstone deposits affect to very considerable degree the constitution of the flora within the forest area.

IV. CLIMATIC.

Situated in lat 34° 56′ S., Adelaide lies about the centre of the area under consideration. The full climatic data for Adelaide extend over a period from 1860 to the present day (Hunt, 1918); the rainfall records are an even longer series, begun in 1839. The full data are given in "Results of Rainfall Observations made in South Australia," 1918, and are summarized annually in "The Commonwealth Year Book." These are the only complete meteorological data for any station in the district, but long series of rainfall records are available for many of the townships included in it. For the purposes of this paper three rainfall stations have been selected as typical of the areas in which the three main forest types recognised by us are developed. They are as follows:—Stirling West, situated near Mount Lofty, at an altitude of 1,628 feet. This is in an area in which the stringybark forest attains its best development. Morphett Vale, altitude 230 feet, lies in a region of low rolling hills about 14 miles south of Adelaide and 4 miles from the sea The district is now largely developed for agriculture, especially the growth of vines, but it retains many traces of the one-time continuous open woodland composed largely of peppermint, *Eucalyptus odorata*. The third station selected is Mount Pleasant, about 1,200 feet high, situated in the northern portion of the area described. The township is some 26 miles east-north-east of Adelaide, in the wide valley of the upper reaches of the Torrens River. This is an area of open forest composed largely of blue gum, *Eucalyptus leucoxylon*. The general climatological conditions will be shortly discussed for Adelaide, but the rainfall records of the three stations named will be given in some detail.

1. General Features of the Adelaide Climate

The climate of Adelaide may be said to be warm temperate, an important factor influencing it being the season of maximum rainfall. Over 80 per cent. of the total annual precipitation (which averages 20·953 inches per annum over a period of 78 years) falls during the months April to October inclusive. This results in two well-defined seasons, one comparatively hot and dry, the other cool and wet. The relation between this seasonal rainfall and evaporation is well shown by fig. 2. The total annual evaporation at Adelaide is 54·419 inches

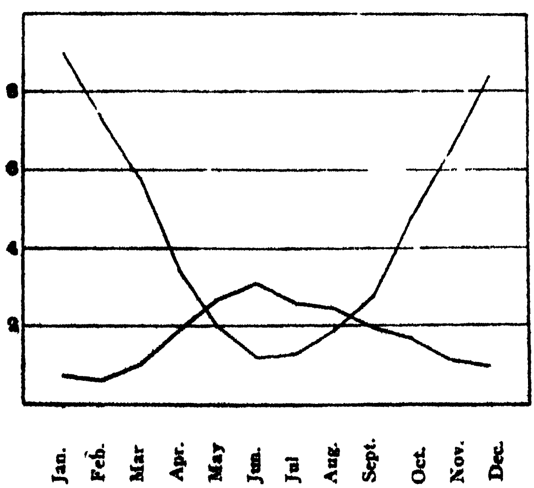


Fig. 2.
Curve showing the mean monthly evaporation and rainfall at Adelaide in inches.

(mean of 47 years), the extremes being 60·953 inches and 46·653 inches. The greatest amount recorded for any one month is for January, 1906, when, with a rainfall of *nil*, the evaporation reached 11·232 inches. The greatest daily evaporation on record is ·560 inches, occurring in December, 1880. A daily evaporation of *nil* may occur between March and October inclusive, and is of common occurrence June to August. Evaporation and atmospheric humidity have such an important effect on transpiration that the following table is of interest:—

Table I.

Mean humidity per cent. at 9 a.m. and 3 p.m., together with mean monthly humidity derived from max. and min. wet bulb readings divided by 2; means over a period of 49 years:—

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean at 9 a.m.	38	41	47	57	68	77	76	69	61	51	43	39
Mean at 3 p.m.	30	31	37	46	57	66	64	57	52	43	37	32
Mean monthly	43	43	49	57	66	73	72	68	64	55	49	45

The mean maximum humidity on record is 94 per cent for a 9 a.m. reading in June, 1857, and the mean minimum is 21 per cent. for a 3 p.m. reading in January, 1915.

Temperature records are available for a period of 60 years and show considerable range. The absolute highest and lowest shade temperatures are 116·3° F. and 32·0° F., respectively. The mean figures for 60 years show that 43·6 days have a temperature of 90° F. and over, 13·5 days per annum exceed 100° F. On the other hand, only on 14·3 nights is the temperature below 40° F. The mean maximum and minimum shade temperatures are as follows:—

Table II.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean max. °F.	86·5	86·2	80·8	73·2	65·4	60·2	58·7	62·0	66·2	72 5	78·6	83·4
Mean min. °F.	61·6	62·1	58·9	54·6	50·0	46·6	44·5	45·9	47·8	51 4	55·3	58·9

In considering the effect of temperature on vegetation the figures for solar and terrestrial radiation are of even more importance than the shade temperatures. These are available for periods of 39 and 56 years, respectively, and are given in Table III.

Table III.

Mean solar and terrestrial radiation (grass). Degrees Fahrenheit:—

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Solar radiat. ..	145·6	144·9	138 7	129·3	118·3	110·7	111·2	117·6	125·5	132·3	138·5	142·8
Terrest. radiat.	54·4	54·5	51·6	47·5	43·4	40·4	38·0	39·5	41·6	45·2	49·0	52·2

The highest temperature on record for solar radiation is 180·0° F. and the lowest for the grass reading is 22·9° F.

These figures, coupled with those for the total number of hours of sunshine (2531·5 on an average of 35 years), show that the insolation factor may be important in determining growth forms of the plants. The harmful effect of minimum temperatures, on the other hand, is rarely felt. Ground frosts may occur between April to October, but are rare in these two months, there being only four cases of frost recorded in April over 45 years and two in October during the same period. The mean maximum for frost occurs on July with 3·3 days. The mean for the whole year during the 45-year period is 7·8 days. Naturally the frost effect is less on the Adelaide plain than in the hills, where, in some of the valleys particularly, the occurrence of winter frosts is common. The forester at Kuitpo attributes the remarkably sharp line that divides the stringybark forest from that of red gum at the edges of certain flat-bottomed valleys to frost influence (Teale, p. 12). He states that stringybark seedlings are very susceptible to frost injury. This may be one of the contributory causes differentiating at their junction what we regard as two distinct forest types.

2. Rainfall Data for Selected Stations.

Rainfall records are given in Table IV. for the three selected stations.

Table IV.

Mean annual rainfall in inches.

Locality	No. of years	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Stirling West	32	1·49	0·95	1·96	4·13	4·83	8·10	6·04	6 15	4·73	3·66	2·10	1·77	45·91
Morphett Vale .	29	0·82	0·58	1·22	2·19	2·56	3·40	2·79	2·71	2·28	1·85	1·32	0·95	22·67
Mount Pleasant ...	40	0·81	0·69	1·23	2·27	2·81	4·31	3·47	3·41	3·05	2·23	1·32	0·96	26·56

In the following three graphs, in addition to the mean annual rainfall, the annual rainfalls for the wettest and driest years on record are given, also the highest and lowest falls on record for any month.

It will be seen that the distribution of the rainfall at all three places is of essentially the same type, *i.e.*, a winter rainfall. The difference in amount between the totals at Stirling West and those of the other two stations is considerable (fig. 6). This difference is due to altitude and proximity to the open sea, which, as Griffith Taylor points out (*l.c.*, p. 99), is well shown in the distribution of rainfall in South Australia as a whole. The district under consideration is amongst the most reliable in Australia so far as annual deviation from the normal rainfall is concerned, but the graphs show that over the periods during which records have been kept considerable deviations from the monthly averages have been recorded. In particular the hot months—December, January, and February—may be almost or quite without rain. It will be seen, however, that in the drought-year curve the deficiency of rain was due to a failure of the winter rains from May onwards rather than to exceptionally dry summer weather.

In considering the climate of these ranges the persistence of cloud at the higher altitudes must be taken into account. This is very marked near Mount Lofty Summit, and an appreciable amount of water which will not affect the annual rainfall must condense upon the vegetation. Precipitation at Mount Lofty is occasionally in the form of snow. The snow rarely lies many hours, and falls, though recorded on several occasions during the past 83 years, are by no means annual occurrences.

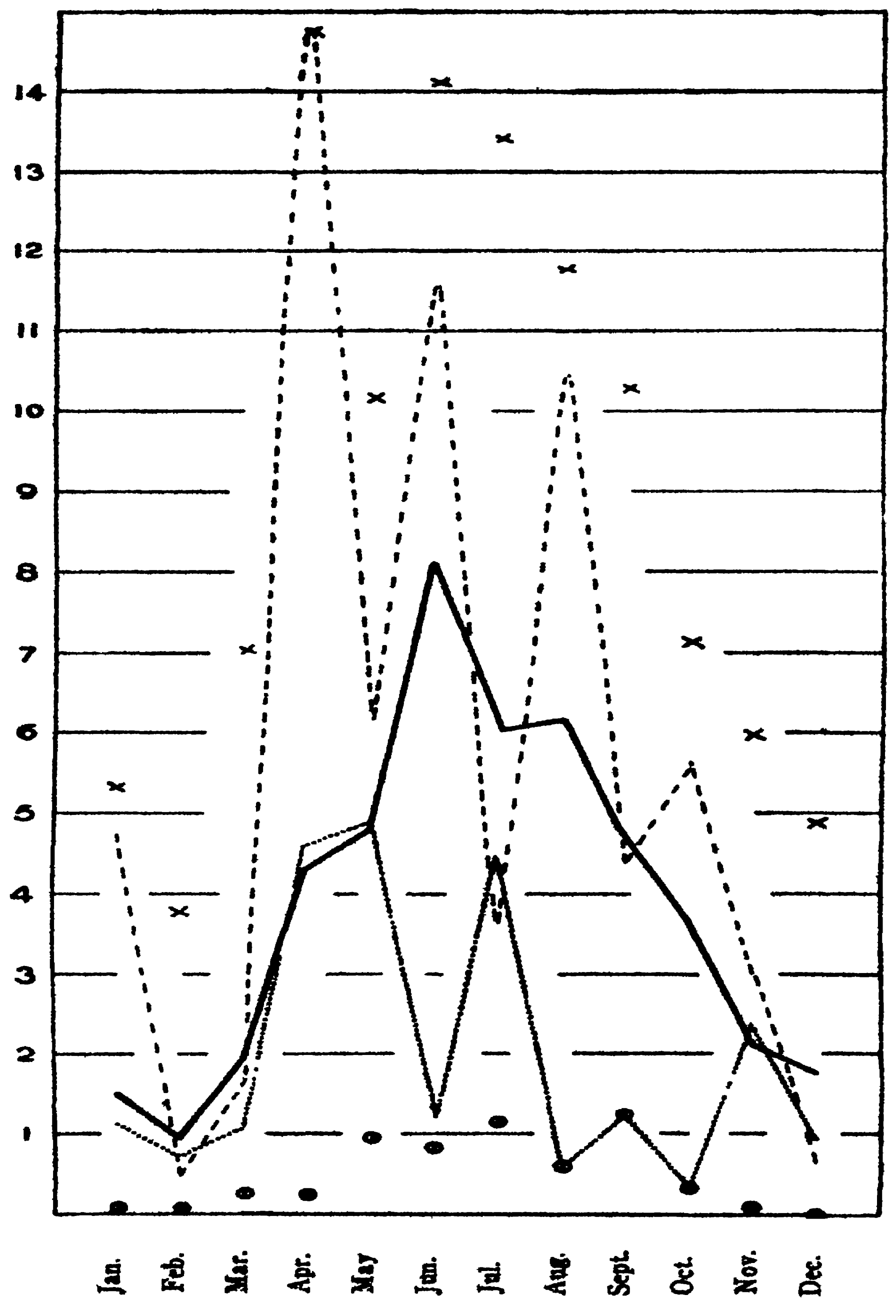


Fig. 3.
Graph of precipitation at Stirling West showing mean annual rainfall on records for 32 years, the curve for the wettest year (1889), the driest year (1914), also the maximum and minimum rainfall for any month during the total period.

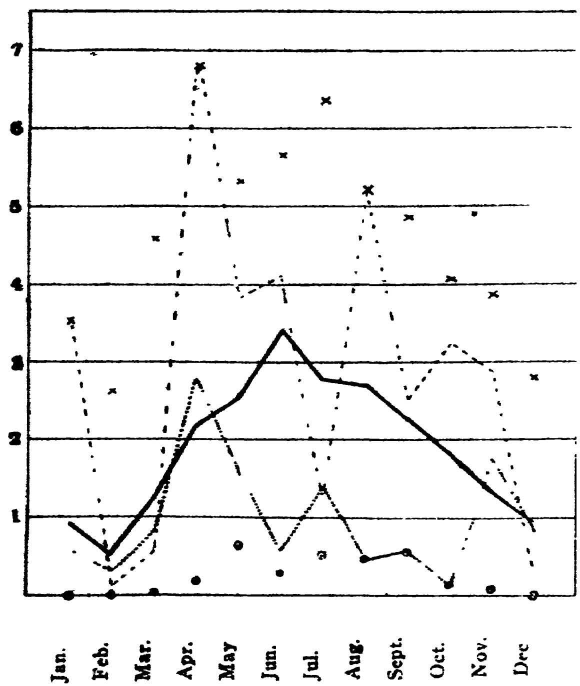


Fig. 4.
Graph of precipitation at Morphett Vale showing mean annual rainfall on records for 29 years, the curve for the wettest year (1889), the driest year (1914), also the maximum and minimum rainfall for any month during the period.

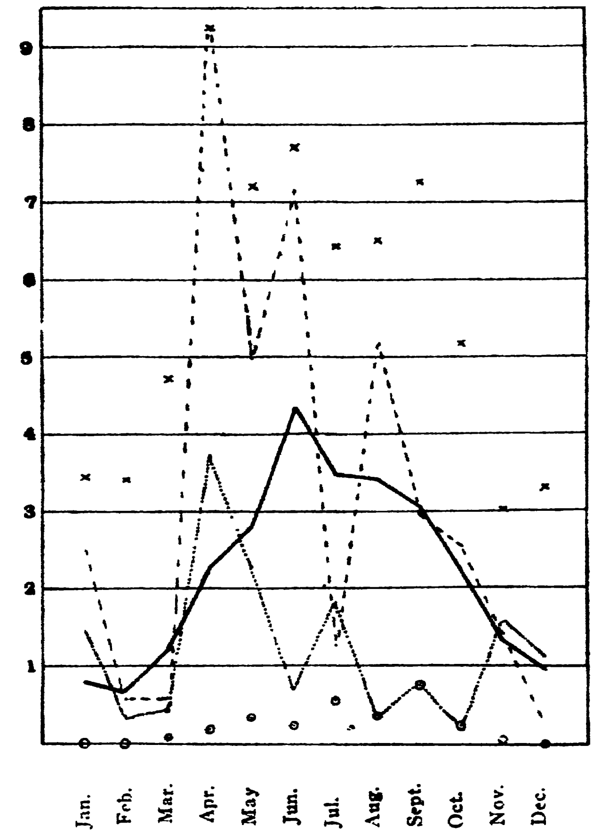


Fig. 5.
Graph of precipitation at Mount Pleasant showing mean annual rainfall on records for 40 years, the curve for the wettest year (1889), the driest year (1914), also the maximum and minimum rainfall for any month during the period.

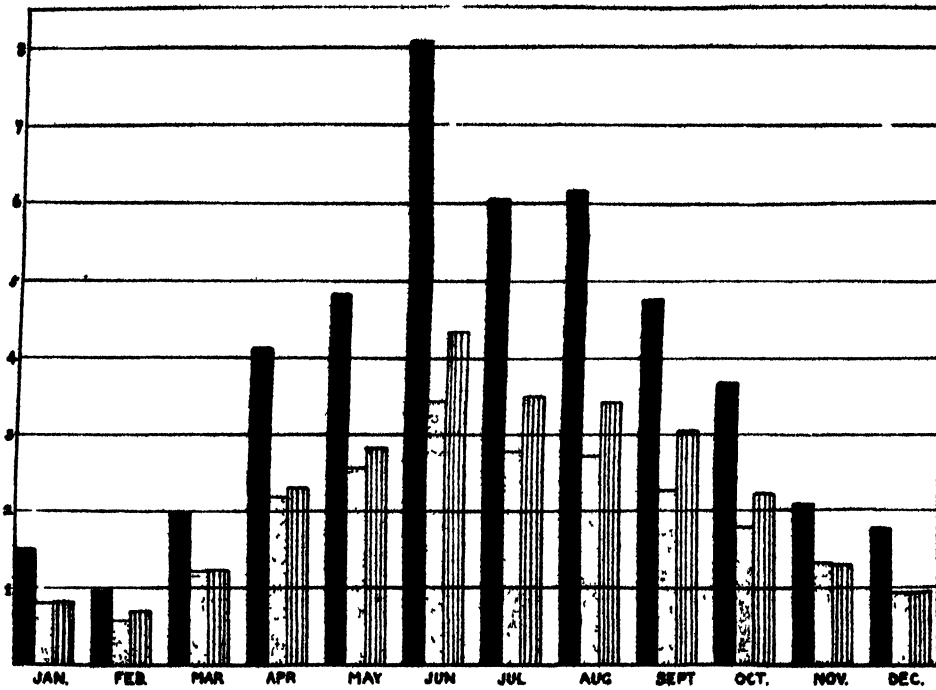


Fig. 6.
Graph comparing the mean annual rainfalls at Stirling West (black) Morphett Vale (stipple), and Mount Pleasant (ruled).

V. PREVIOUS WORK.

Very little has been published previously on the ecology of this region, though much floristic work has been done. A short paper by one of us (Osborn, 1914) may be cited as distinguishing between the savannah type of forest on the plains and hills of nonsilicious rocks and the stringybark forests or scrub on soils formed from quartzitic rocks. A second short paper (1918) describes in some detail a rather specialized type of plant community, the seasonal swamp, interesting as the habitat of *Phylloglossum Drummondii* and *Isoetes Drummondii.* In the bulletin on the "Soil Survey and Forest Physiography of Kuitpo" already cited (Teale), the principal forest trees are connected with the soil types on which they grow within that area.

VI. VEGETATION.

In the following pages the vegetation is described under the chief communities that we have recognised in the field. Additional notes on climatic or physiographic features are given in connection with the vegetation types that are influenced by them.

1. Stringybark (Eucalyptus obliqua) Forest.

Forests of stringybark cover the main ridges of these hills, whose core is composed of quartzites or other rocks that are rich in silica. The soil derived from these rocks varies somewhat (see ante, p. 90). The harder quartzites produce a shallow, coarse, sandy soil; other beds give a finer-grained soil, but always with a high percentage of sand. Locally, deep sandy soils are formed.

These silicious soils have all the appearance and characters of relatively "acid" soils which are poor in soluble gases, though no large series of determination of the reaction have been made. Preliminary tests of the pH support this view. These sandy and ironstone soils occur as the backbone of the range and occupy nearly all the country receiving an annual rainfall of 30 inches or more.

The whole area is naturally a forest region; except when clearing has been carried out, almost the only break in the forest cover occurs in flat-bottomed swampy valleys. While the forests vary somewhat in character, the major part is composed of *Eucalyptus obliqua,* here known as stringybark, though in the Eastern States this tree is termed "Messmate." This tree occurs pure over great areas, but may be associated with other species of the genus *Eucalyptus.*

The Chief Tree Species.

E. obliqua may attain a considerable size, though in the forests on these ranges trees over 80-90 feet are rare. The trees do not form a close canopy (pl. x., fig. 1), and especially when mature stand at considerable distances from one another. This species, like the majority of the genus, has pendant leaves, which thus do not cast a dense shadow. All through the forests regeneration takes place readily from seed, especially after cutting or firing, also from coppice shoots. In nearly all the forests young trees of all ages can be found, especially in the spaces between the large trees. *E. obliqua,* like so many other species of *Eucalyptus,* is a marked light-demander and intolerant of shade at all stages of its life. This is very obvious in forests composed of old trees · here regeneration is quite absent within the sphere of shading of the old trees, while in gaps between a thick growth of young trees occurs.

E. obliqua, as mentioned, may be associated with or even locally replaced by other species. Among these is another stringybark, *E. capitellata,* which occurs especially on the poorer and shallower soils. This is a tree very similar in general appearance and growth to *E. obliqua,* and in the absence of fruit is not very easily differentiated in the field. *E. capitellata* has, in general, a darker and more furrowed bark, and in the crown a less even distribution of foliage, the leaves being bunched towards the extremities of the branches.

Local bushmen in many cases do not seem to differentiate clearly between these two trees. They do distinguish two kinds of stringybark, using two different criteria: the colour of the timber, either yellow or white; and secondly, the thickness of the bark. Trees with a very thick bark are called "Woollybutts." But timber of both colours may occur in either species, and we have had trees pointed out to us as stringybark and woollybutts, respectively, which botanically were undoubtedly the same species. In both species age, and also the nature of the soil and habitat generally seem to have a decided influence on these features.

Another species of stringybark, *E. muelleriana,* which is very closely allied to *E. capitellata,* is recorded from Mount Lofty (Maiden, p. 220), but seems scarcely distinguishable here.

Besides these, *E. fasciculosa,* pink gum, and *E. cosmophylla,* scrub gum, occur in the forests. Other trees are not common, *E. viminalis,* manna gum, is confined to deep gullies, where also some other plants may attain tree size, as is described later; *Casuarina stricta* occurs on rocky slopes, but not in the forest proper.

The Life-forms and Leaf-types.

The undergrowth in these forests varies considerably in its composition in different parts, but all through it has one general facies, consisting, as it does, of a more or less dense growth of xerophytic undershrubs. These stand on the

average about 2-3 feet in height, though much taller growths occur. This undergrowth has a dark, often brownish, colouration that is in many ways reminiscent of a European heath growth. Before the details of the distribution of the undergrowth are considered, a word or two may be said about the general life-forms and leaf-types.

While the leaf of the dominant tree is somewhat of the sclerophyll type, the undergrowth as a whole is characterised by the possession of small leaves which are often ericoid or cylindrical. Such leaves are shown by the Epacrids *Astroloma Sonderi, Epacris impressa, Leucopogon virgatum,* also by *Tetratheca ericifolia, Daviesia ulicina, Dillwynia hispida, Gompholobium minus,* and by the *Proteaceae, Persoonia juniperina, Grevillea lavandulacea, Hakea ulicina, H. rostrata; Isopogon ceratophyllus,* with its very hard divided leaves, may also be classed here. Other common plants with this general leaf-form are *Hibbertia acicularis, H. sericea,* and *Calythrix tetragona.* Pungent leaf-points are a common feature.

Larger and broader leaves of a sclerophyll type are possessed by *Banksia maginata, Pultenaea daphnoides, Daviesia corymbosa,* and by the phyllodes of *Acacia myrtifolia. Dodonaea viscosa* has broad and rather thin leaves which, however, have a lacquer-like varnish on the surface (Collins), a feature also possessed by *Ixodia achillaeoides, Spyridium vexilliferum,* and others.

Aphyllus plants, or plants with very reduced leaves and an assimilating stem, are not very prominent; besides two species of *Casuarina,* there are *Daviesia brevifolia, Acacia spinescens,* the parasitic *Exocarpus cupressiformis,* and a few others.

Xerophytic monocotyledons are relatively abundant; the long, hard, glaucous leaves of *Xanthorrhoea semiplana* and more locally of *X. quadrangulata* are quite a feature of the undergrowth. Other common xerophytic monocotyledons are species of *Lomandra (Xerotes)* and of *Lepidosperma.*

Hairy leaves are by no means common, so that *Hibbertia sericea* appears quite exceptional. A few plants such as *Banksia maginata* have appressed hairs on the under surface of the leaf, but the vast majority of the shrubs are almost or quite glabrous. Leaves covered with hairs, however, are found among the smaller plants which come up in the early summer, as, for example, *Helichrysum apiculatum, Dampiera rosmarinifolia,* and *Brunonia australis.*

A number of geophytes occur in the forests, though no individual species is abundant. These plants are much less markedly xerophytic; most of them, however, have few leaves or even only a single one. The leaves are either narrow, as in *Bulbine bulbosa, Burchardia umbellata, Cassia vittata,* and *Dichopogon strictus,* or, when broader, are closely pressed to the surface of the soil. Such surface leaves are a feature of several orchids, *Acianthus, Corysanthes, Lyperanthus,* species of *Pterostylis,* and others. All the geophytes have a short vegetative and flowering season; they appear in the spring after the winter rains, but in most cases by midsummer very little trace of them can be seen above ground.

Grasses occur, but as scattered individuals, and nowhere give character to the undergrowth; the most abundant are *Stipa* spp., *Dichelachne* spp., and *Danthonia penicillata.*

Climbing plants are strikingly rare in these forests, and none of any size are present. The most abundant is the parasitic *Cassytha.* Other climbers are the beautiful *Marianthus bignoniaceous* and *Hardenbergia monophylla,* with rather broad shining leaves, the former being confined to sheltered moist gullies. *Billardiera cymosa* occurs, but scrambles rather than climbs. Of the few herbaceous climbers *Glycine clandestina,* a vetch-like plant, and *Thysanotus Patersonii,* are the most common.

Epiphytes are quite absent. Even bryophytes and lichens do not flourish here on the trees. In this connection it may be noted that lichens do become common on dead limbs of trees when the bark has fallen off. They are also abundant on the living barks of many introduced orchard or ornamental trees. Their absence on living trees of the forest, then, may have some relation to the deciduous bark of the "gums" or the thick fibrous bark of the stringybarks. The liverwort *Cheiloscyphus exilifolius* is a common feature of charred trunks of stringybarks.

These forests possess a considerable number of parasitic plants Besides *Exocarpus,* of which mention has already been made, there are quantities of *Cassytha,* both the larger *C. melantha* and the smaller *C. glabella.* Both grow on a considerable range of host plants, and both commonly twine round shoots even when no haustoria are formed. *C. glabella* especially is a very characteristic feature of the undergrowth. *Loranthus* occurs, but stringybarks are much less attacked by *L. Miquelii* than are many gum trees. It is often quite striking how abundant this parasite becomes when one passes from a forest of *E. obliqua* to one of, say, *E. leucoxylon.* While in the former the trees are almost free from *Loranthus,* in the latter they are often covered by it, hardly a tree in a forest being free. *L. Exocarpi* occurs on *Exocarpus,* species of *Acacia,* and other shrubs. Besides these the semiparasitic *Euphrasia Brownii* is locally abundant.

Saprophytes are represented by the peculiar chlorophyll-less orchid *Dipodium punctatum,* which is, however, not at all common.

While noticing these parasitic plants, it may be remarked in passing that a very large number of plants, trees, shrubs, and herbs are commonly deformed by galls caused by either insects or fungi, notably *Uromycladium Tepperianum* on *Acacia* spp.

Communities of the Forest.

The actual composition of the flora in the stringybark forest varies considerably in different parts; the variations depend on changes in soil, topography, and of climate. For purposes of description four main types can be recognised, namely, forests on quartzite soils, on ironstones, stunted forests on glacial deposits, and forests in sheltered gullies.

Forests on Quartzite Soils.

These are the most extensive, and as such may be treated as typical. A very characteristic community here is present on the plateaux of the larger quartzite ridges where the rainfall is 25 inches or over. On Mount Lofty itself rainfall as much as 44 inches is recorded. The soil under these conditions is sandy but shallow, being not over 12 inches in depth, and often much less. Stones are frequent. No distinct humus layer is present, though the surface soil is somewhat dark coloured. Here the canopy is usually composed of pure *E. obliqua,* though *E. capitellata* may occur locally mingled with it. The undergrowth consists of a varied assemblage of shrubs and smaller plants which rarely form really continuous layers (pl. x., fig. 2). Among the most abundant and characteristic are *Acacia myrtifolia* and *Pultenaea daphnoides.* Other prominent plants are *Hakea rostrata, Epacris impressa, Astroloma Sonderi, Leucopogon virgatum, Daviesia corymbosa, Platylobium obtusangulum, Tetratheca ericifolia, Xanthorrhoea semiplana, Lepidosperma semiteres,* while less abundant are *Astroloma humifusa, Hibbertia acicularis, Grevillea lavandulacea, Persoonia juniperina,* and *Isopogon ceratophyllus.* Among the more prominent of the smaller or seasonal plants may be mentioned *Drosera Menziesii, Cassytha glabella, Lomandra (Xerotes) dura, Goodenia geniculata, Brunonia, Wahlenbergia gracilis, Craspedia Richei,* and a great many others.

When the trees are large this undergrowth is irregular in its distribution; in the shade a very open and scattered assemblage is present, while a dense growth with numerous young trees occurs in the open spots.

These forests are very liable to damage from bush fires; the long, warm, dry summer and the prevalence of volatile oils in the plants are both contributory factors Indeed, there are few if any existing forests on these ranges which have not at some time or another been burnt. The severity of the damage varies greatly; in some cases the undergrowth alone is burnt, while at other times the trees are also affected. The stringybark, however, is a tree exceedingly resistant to fire damage; even when the fire reaches right up to the crown it is, as a rule, not killed, but sprouts out afterwards from numerous dormant buds on the stem and branches (pl. xi., fig. 1). Many of the extremely irregular shapes assumed by these trees can be related to this periodic destruction of the smaller branches by fire and subsequent sprouting of dormant buds. It requires a very severe fire indeed to kill mature stringybark trees.

After a fire a vigorous crop of seedling trees appears. The capsules are very resistant and not destroyed, though the heat causes them to open and to shed the seeds.

After a fire it is not infrequent to find tree seedlings appearing as the most conspicuous part of the undergrowth. Regeneration of the undershrubs takes place, however, rather quickly. After a light ground fire it may be direct owing to shoots from adventitious buds which are developed after a fire or mechanical injury upon the roots of many species. A more severe burn causes considerable changes before the typical condition is again established. Certain plants seem to be stimulated to increased growth and reproduction by a forest fire. A noticeable example of this is *Xanthorrhoea semiplana.* This plant rarely produces flower and fruit unless a fire occurs (pl. xi., fig. 2). In the season following a fire it produces a remarkable picture, a forest of stiff erect spikes of its white flowers appearing. After a rather long interval the composite *Ixodia achilleoides* appears in great abundance, and for two, three, or even more seasons takes a very prominent place in the undergrowth (pl. xii., fig. 1). Owing to the abundance of this plant, with its relatively wide lacquered leaves, the undergrowth has a fresher, greener appearance shortly after a fire than at other times. After about three years *Ixodia* comes to be associated with other plants whose seeding is favoured by fire, namely, *Hakea rostrata, H. ulicina,* and *Leptospermum myrsinoides,* whose slower growing seedlings have not been apparent in the earlier stages. The latter especially becomes very abundant and gradually ousts the *Ixodia.* The presence in these forests of large quantities of *Xanthorrhoea semiplana* and *Leptospermum myrsinoides,* with or without *Ixodia achilleoides* may almost be taken as an indicator of a previous bush fire. The other plants gradually reassert themselves; *Acacia myrtifolia* is much more rapid in regeneration than *Pultenaea daphnoides* and many others.

Effect of Local Changes in the Environment.

Changes in the flora occur in drier situations. On the lower hills, with a less rainfall, and on open slopes, where the soil has little power of retaining moisture, *Pultenaea daphnoides* and *Acacia myrtifolia* are very much less abundant or are even quite absent. The former may be replaced to some extent by the small-leaved *P. graveolens.* On the other hand, *Astroloma Sonderi* and *Tetratheca ericifolia* occur in greater quantity, while *Hibbertia sericea* and *Olearia tubuliflora* are often abundant. At lower altitudes *Acacia pycnantha* may be present in some quantity.

Some variation in the flora occurs on the slopes in accordance with the exposure, whether they receive the full glare of the sun or not. Those slopes

that face the south have a flora closely approximating to that on the higher plateaux. In some cases, where the angle of the slope is high and little direct midday sun reaches the ground, the flora includes species which are characteristic of sheltered and relatively moist conditions. Among such are *Acrotriche fasciculiflora*, which may locally approach dominance, *Senecio hypoleucus*, *Logania linifolia*, *Olearia grandiflora*, and sometimes *Acacia melanoxylon*. The ferns also, *Cheilanthes tenuifolia* and, locally, *Pteridium aquilinum* may be present in some quantity. In contrast to this flora, on slopes with a northern exposure very much more xerophytic conditions are apparent. *Acacia myrtifolia* and *Pultenaea* are quite absent, while such plants as *Hibbertia sericea*, *Olearia tubuliflora*, and, locally, *Xanthorrhoea quadrangulata* are abundant. The pink gum, *Eucalyptus fasciculosa*, is present in greater amount on these sunny slopes and may locally replace the stringybark (pl. xii., fig. 2).

When the slope becomes very steep and rocky, and so is liable to frequent and continued drought, stringybark may be absent, or at most only descend a short distance from the plateau. Its place is taken by a rather stunted forest of *E. fasciculosa*, which has a xerophytic undergrowth in which *Hibbertia sericea*, *Olearia tubuliflora*, *Hakea rostrata*, and *Tetratheca ericifolia* are the chief species, along with *Astroloma Sonderi*, *Hybanthus floribundus*, and *Pimelea glauca*. Such plants as *Acacia myrtifolia*, *Pultenaea daphnoides*, *Epacris impressa*, and others are here confined to gullies and watercourses. This scrub forest of pink gum is developed on the sunny northern slopes of ridges, and a sharp contrast is obtained on comparison with the southern slope, which, though equally steep, has a forest of *E. obliqua*, with an undergrowth of Epacrids, *Platylobium* and such plants.

Where the slope becomes so steep that it assumes the aspect of a cliff, and little or no surface soil is present, *Eucalyptus* forest is absent; its place is taken by an open community in which *Casuarina stricta* and *Xanthorrhoea quadrangulata* are the most prominent plants. The former assumes the stature of a low tree, while *Xanthorrhoea* varies in height from 2 feet to as much as 10 to 12 feet without considering the crown of leaves or the inflorescence. Associated with these two is a more or less open assemblage of plants which creep on the ground or are of dwarf stature, *Astroloma humifusa*, *Hibbertia sericea*, *Olearia tubuliflora*, *Pimelea glauca*, and *Astroloma Sonderi*. Amongst these are scattered a number of herbaceous plants which are more prominent here than in the general forest; the most abundant are *Goodenia geniculata*, *G. pinnatifida*, *Scaevola microcarpa*, *Brunonia australis*, *Halorrhagis tetragyna*, and, locally, *Themeda triandra* (=*Anthistiria ciliata*). Besides these *Lomandra (Xerotes) dura* and *L. micrantha*, and occasionally *Cheilanthes tenuifolia* are frequent. At the foot of cliffs or at the bottoms of valleys bushes of larger size may occur here, especially *Dodonaea viscosa*, *Anthocercis angustifolia*, and locally, *Acacia rupicola*.

The relative proportion of *Casuarina stricta* varies with the aspect and with the local conditions. It is most abundant where solid rock outcrops, and less so on broken rock. On cliffs with a southern exposure especially it becomes luxuriant, and may form closed communities, a condition that also occurs on the steep sides of narrow gorges. *Casuarina stricta* also replaces the Eucalypts where rock comes to the surface, not only on such slopes as described, but also on the edges of ridges and by waterfalls.

Forests on Ironstone Soils.

(a) Coarse Ironstone Soils.—As was mentioned earlier, ironstones are of two kinds, namely, a quartzitic soil impregnated and partially cemented by iron

and a solid, rather fine-grained ironstone rock. These two kinds of ironstone bear vegetation that is very different and will be described separately.

The vegetation on the quartzitic ironstone gravels is not very different from that on the ordinary quartzites. *E. capitellata* is generally present associated with the dominant *E obliqua.* The undergrowth is sparser and more open, *Acacia myrtifolia* and *Epacris impressa* are much less abundant. Such plants as *Hakea ulicina, Daviesia ulicina,* and *Pimelea glauca* are abundant. Small plants as *Kennedya prostrata, Halorrhagis tetragyna, H. ceratophylla,* and *Helichrysum scorpoides* are more prominent. Locally the orchids *Thelymitra grandiflora* and *Pterostylis vittata* are frequent.

While these forests that occur on this kind of ironstone are very closely allied to those on quartzite soils, a distinct type is developed in situations where the rock itself is impregnated with iron. Here generally the soil is very shallow though sandy The trees are here smaller and stand further apart from one another. *E capitellata* is, as a rule, the most abundant, and, while it may occur in association with *E. obliqua,* frequently stands alone. *E. fasciculosa* occurs as an undertree, and occasionally plants of *E. cosmophylla* may be present. In the undergrowth the most prominent plant is undoubtedly *Casuarina distyla.* This plant is exceedingly variable both in its size and general form. It occurs in all sizes from a small undershrub of 1 to 2 feet up to trees of 10 to 15 feet, and varies almost as much in its general shape. Most commonly it forms a spreading bush with no distinct main axis; at other times it is erect with rather fastigiate branching The tree forms have ascending branches. How far some of these forms are distinct races or varieties is a matter that certainly calls for study and attention

Along with this *Casuarina* the most abundant plants are *Xanthorrhoea semiplana, Calythrix tetragona, Astroloma Sonderi, Daviesia brevifolia, Isopogon ceratophyllus,* and *Hybanthus floribundus,* with lesser quantities of *Pimelea glauca, Spyridium vexilliferum, Dillwynia hispida, Hakea rostrata, Pultenaea villifera,* and others. In such situations *Lomandra (Xerotes) filiformis* frequently occurs in large grass-like tufts. The resemblance to a grass is heightened owing to the fact that *Danthonia penicillata* frequently finds a nidus in the centre of such a patch, and its inflorescences appear above the surrounding leaves of the liliaceous plant. *Neurachne alopecuroides* occurs not infrequently on these ironstones. The general aspect of the undergrowth is more xerophytic than on the quartzite soils; a greater proportion of the plants have small leaves with pungent points.

Where these rocks occur on steep sun-baked slopes the forest is replaced by a scrub with only scattered, stunted, bush-like trees of *E. fasciculosa.* The bulk of the vegetation is composed of *Casuarina distyla, Xanthorrhoea quadrangulata,* with *Astroloma Sonderi* and *Calythrix tetragona.* Other abundant plants are *Hybanthus floribundus, Daviesia ulicina, Leucopogon virgatum, Xanthorrhoea semiplana, Lepidosperma viscosum,* and many others.

This assemblage, along with a large number of subsidiary species, forms a highly xerophytic scrub that bears much resemblance to the maquis of the Mediterranean coasts. As forests of *E. capitellata* and *E. fasciculosa* occur wherever a plateau is reached and in gullies, it would seem that this scrub is a community prevented from its full development owing to the physiographic factors.

These ironstone communities are as frequently devastated by fire as are those of the quartzite. Regeneration here is, however, generally more direct; *Casuarina distyla* sprouts very readily from the stool, and *Xanthorrhoea* is constantly encouraged in reproduction by fire. While *Ixodia achilleoides* and *Leptospermum myrsinoides* do appear after fire, they never become so

important in the vegetation as is the case in the forests described earlier. The very rapid regeneration and spread of the *Casuarina* after fire may to a large extent inhibit the establishment of seedlings of *Eucalyptus,* and some of the areas of *Casuarina-Xanthorrhoea* scrub on this type of soil which have scattered trees may well be the result of fire and the subsequent prevention of tree regeneration by the rapid strong growth of these plants.

(b) Fine Ironstone Soils, Eucalyptus cosmophylla Scrub.—When one passes to a region of the hard, fine-grained, ironstone rock a change in the vegetation is at once apparent. Forest ceases often quite abruptly, and its place is taken by a dense scrub that rises only 4-10 feet. The characteristic and dominant plant here is the scrub gum *E. cosmophylla.* The transition to this scrub may be quite a sharp line, or in some cases there is a transition zone where dwarfed trees of *E. capitellata* and *E. obliqua* occur with the scrub gum. Where growing luxuriantly *E. cosmophylla* forms very dense thickets in which other plants are suppressed except in spaces between the dwarf trees. The most general associated species are *Xanthorrhoea semiplana, Casuarina distyla, Daviesia brevifolia, Isopogon ceratophyllus, Hakea rostrata, H. ulicina, Leucopogon virgatum, Astroloma humifusa,* and *Leptospermum myrsinoides,* with many others in less quantity. After fires the *Xanthorrhoea* increases considerably and for a long period may hold its place in competition with the gum which regenerates readily but slowly.

These scrub communities of *E. cosmophylla* occur for the most part on the relatively level ground on the tops of ridges, but can also maintain themselves on steep slopes. On some of the lower flat-topped ridges and watersheds the solid ironstone may be some distance below the surface and be overlaid by 2-3 feet of a soil of a loamy consistency which is very retentive of water in winter but becomes baked very hard and dry in the summer. In this type of locality the shrubby trees are much more stunted, frequently not attaining a greater height than 3 feet. Besides their small size they are more scattered and attain a much less degree of dominance; *Xanthorrhoea semiplana* is here very abundant and takes an almost equal part with the eucalypt in controlling the community. On this soil some small moisture-loving species are exceedingly abundant in the Spring, notably *Drosera Whittakeri, Schoenus apogon,* and *Chamaescilla corymbosa.*

Scrub communities of *E. cosmophylla* are not solely confined to these hard ironstones, but also occur on portions of ridges where the rock is a hard crystalline quartzite which weathers slowly to a shallow, rather compact soil. In this case the flora is more like that of the stringybark forest; *Casuarina distyla* is not abundant, while *E. fasciculosa* and *E. capitellata* in a stunted form are frequent, though they scarcely compete for dominance with the scrub gum The most general associated plants are: *Xanthorrhoea semiplana, Astroloma Sonderi, Leucopogon virgatum, Acrotriche serrulata, Leptospermum myrsinoides, Hibbertia sericea, Hakea rostrata, H. ulicina, Daviesia ulicina,* with more locally some quantity of *Lissanthe strigosa, Acacia myrtifolia, Calythrix tetragona, Tetratheca ericifolia,* and *Isopogon ceratophyllus.*

These communities are in most respects intermediate in their characteristics between the stringybark forest and the typical scrub-gum community. This intermediate feature is correlated with their habitat, which agrees with the ironstone one in having a very hard resistant rock and a relatively fine-grained soil, while it approaches the quartzite habitat in the siliceous and rather sandy nature of the soil.

All these scrub communities of *E. cosmophylla* are very closely allied to the *E. obliqua* forest and seem to represent variations due to local changes in habitat. The great difference in the growth habits of the two dominants gives an impression of much more wide divergence than a closer study shows to actually

exist. A study of the associated species and undergrowth shows that all the plants occurring in the scrub communities also occur in the forest. The relative frequencies are different, and many of the forest plants are absent from the scrub, but our studies have not revealed a single species peculiar to the latter. As might be expected from their habitat, the scrub communities are more markedly xerophytic than the general forest. The broader-leaved and shelter-loving species are either absent or present in very much reduced quantities. Thus *Pultenaea daphnoides, Epacris impressa, Daviesia corymbosa,* and *Platylobium obtusangulum* are rare, while *Olearia grandiflora, Exocarpus cupressiformis,* and *Acacia myrtifolia* are absent. Even in those communities on the deeper poorly-drained soils this xerophytic facies is apparent; the only moisture indicators are small plants, geophytes or annuals, which flourish in Winter and Spring. *E. cosmophylla* itself has harder and thicker leaves which are wax covered and have the appearance of more marked xerophytic features than those of the forest trees.

Scrub on Glacial Deposits.

As mentioned earlier, in the southern parts of the ranges the solid rock for considerable stretches is overlaid by glacial deposits of Permo-carboniferous age. These are specially well represented on the watershed between Willunga and in the neighbourhood of Mount Compass. Those glacial deposits may be of very considerable thickness. They vary greatly in character; while some are consolidated to rock, most are loose (Howchin, 1910). The soils produced are largely sandy, though ironstones occur not infrequently. The soils are nearly all very retentive of water but liable to great drought in summer.

The vegetation on these soils is very characteristic; trees are quite absent. The ground is clothed by an open scrub not rising more than 4-6 feet, and generally very much less. The composition of the scrub is variable; the plants very often grow in groups or patches. Some of these are determined by local edaphic conditions, while others seem rather to be the result of the habits of growth and reproduction of the plants and of competition.

The plant which perhaps gives most character to the scrub is a dwarf form of *Eucalyptus capitellata,* which here grows commonly as a branching bush 2-6 feet in height, and rarely exceeds 6-8 feet. These small-sized bushes may be of very considerable age and produce flowers and fruit quite freely. The relations of this dwarf form to the tree form and the exact determining conditions for each are subjects well worthy of detailed work. *E. fasciculosa,* also in a dwarfed state, also occurs here, but is much less abundant. While *E. capitellata* gives a general character to the scrub, it cannot be described as dominant. It occurs as local patches and scattered individuals (pl. xiii., fig. 1). Along with it, and often also occurring in patches, the most abundant of the larger plants are: *Casuarina distyla, Hakea ulicina, H. rostrata, Pultenaea villifera, Banksia marginata* (a dwarf form), *B. ornata* (generally more abundant than the first-named species), *Daviesia brevifolia, Isopogon ceratophyllus,* and *Xanthorrhoea semiplana. Acacia myrtifolia* is locally abundant. Amongst and between these plants there occurs a varied assemblage of smaller undershrubs, some of which are very characteristic here, though not occurring in the forests. Perhaps the most abundant of these restricted plants are: *Conospermum patens, Adenanthos terminalis, Boronia caerulescens, Pultenaea villifera, Spyridium parvifolium, Baeckea diffusa.* Also abundant but of wider distribution are: *Grevillea lavandulacea, Platylobium obtusangulum, Dillwynia floribunda, Daviesia ulicina, Correa speciosa, Cryptandra hispida, Calythrix tetragona, Pimelea octophylla, P. glauca, P. phylicoides, Leucopogon concurvum, L. virgatum, Astroloma Sonderi, A. humifusa, Epacris impressa,* while a large number of others occur more occasionally.

Among the numerous herbaceous plants mention may be made of *Helichrysum Baxteri, H. semipapposum, H. Blandowskianum,* and *Euphrasia Brownii,* which are abundant and characteristic. The scrub is an open community with frequent patches of bare soil between the plants and with an exceedingly varied flora. Besides the plants already mentioned, *Cassytha melantha* is here exceedingly abundant, often forming large sprawling patches on the bushes and binding them together. The leafless semi-parasitic *Choretrum glomeratum* occurs here and appears to take the place of *Exocarpus* in the forests. It may be mentioned, as a contrast to the ironstone communities, that *Casuarina distyla* here is always a low shrub, indeed it not infrequently has a semi-decumbent habit, forming large circular patches in which the main branches are horizontal and on the surface of the ground, while the assimilating shoots stand erect.

In some parts of this area the soil is a deep rather loose sand, and in such situations rather a marked change in the flora occurs. The shrubs are almost or quite absent, *Xanthorrhoea* is present, but the flora is essentially herbaceous and of low stature. The chief species are two species of Restionaceae, *Hypolaena fastigiata, Lepidobolus drapetecoleus,* and *Gahnia lanigera,* which form an open community in which are scattered individuals of *Poranthera ericoides, Xanthosia dissecta,* and others. These sandy patches are generally of limited extent, but are quite sharply defined; one passes suddenly from the dwarf *Eucalyptus-Casuarina* scrub to the open community containing Restionaceous plants.

Another change of flora due to local edaphic conditions is seen here in those parts where ironstone is developed. This ironstone is chiefly found as a capping to the low rather rounded hills. Here the characteristic *E. capitellata* is replaced by a dwarf form of *E. cosmophylla,* which here forms a scrub about knee high. It occurs almost pure or mixed with *Casuarina distyla,* which is always very low. On these ironstones the flora is much less varied and poorer in species. Only the most xerophytic seem able to attain a footing; the most abundant are *Xanthorrhoea semiplana, Hibbertia sericea, Hakea rostrata,* and *Leucopogon virgatum.* Such plants as *Correa, Conospermum, Pimela, Epacris,* and others are absent. A few species are more abundant here, the most noteworthy being *Stylidium graminifolium, Persoonia juniperina,* and *Tetratheca ericifolia.* Herbaceous plants are conspicuously less abundant here.

The development of low scrub communities on these ancient glacial drifts seem mainly determined by edaphic conditions. In the Mount Compass region the summits and upper slopes of some of the hills have been cleared of drift by erosion, and the solid rock, here Pre-Cambrian gneiss or quartzitic schist, is laid bare. In such places, unless the exposure to wind and sun is very great and the rock area very small, the scrub is replaced by a tree growth of *E. fasciculosa* or a form of *E. cosmophylla* that attains a height of 20-30 feet. The undergrowth is also quite different and like that of dry, rocky, stringybark forests. At the limits of the drift-covered area there is quite a narrow zone of transition between the forest and the scrub.

A study of the flora and its relations to soil variation leads to the conclusion that there is a close alliance between the scrub on glacial soil and the stringybark forest. Not only is the general facies of the flora very similar, but there is also a very high percentage community of species. Though dwarfed in form there is the same relation to soil conditions between *E. capitellata* and *E. cosmophylla* existing in the scrub, as was described earlier in the forest. Further, it is interesting to note that in the stringybark forest, where, in a few localities, the soil is a deep loose sand, some of the very characteristic plants of the scrub are present. The trees are *E. capitellata,* and in the undergrowth there occur *Pultenaea villifera, Conospermum patens,* with locally an abundance of *Hypolaena fastigiata.* Generally speaking, one might say that there is the same flora, but

in one case with trees, in the other with low bushes of the same species. Further consideration of the relationships of this scrub is, however, deferred till later.

Gully Forests.

As was mentioned in an earlier part of this account, the Mount Lofty Range is penetrated by numerous ravines and gullies carved out by the erosive action of streams through long periods of time. Gullies have been cut both by the streams forming the drainage system of the ranges themselves and by rivers which rise on the eastern side of the watershed, but which have cut gorges right through the hills. Among the rivers which have cut through in this way are the Torrens and Onkaparinga. The gullies or gorges are generally deep and with steep sides. They have a moister atmosphere, or, at any rate, one in which the plants are exposed to less rigorous conditions.

These more favourable conditions are due to the presence of a stream only to a minor extent. Except for a very small number, the streams become dried up in summer; even the rivers may cease flowing and be represented by a series of pools. Factors of equal or greater importance are protection from wind and from the direct rays of the midday sun or from sunlight for many hours each day, all of which lead to a reduced evaporation rate Another important factor is that such gullies receive a much greater and more constant precipitation of dew. This is the result of radiation and air drainage. About sunrise, especially in early Summer, it is no uncommon thing for the valleys to be saturated with moisture while the open slopes and ridges appear quite dry. Further, the soil in the gullies is finer grained, and not only more retentive of moisture, but, of course, receives the run-off after rains.

These various conditions combine to produce considerable differences in the forests which have a flora of a distinctly less xerophytic type. Many plants with relatively broad and thin leaves are present, and ferns and bryophytes are prominent here, though nowhere conspicuous, and often quite absent in the general forest.

While the forest is mainly composed of *E. obliqua*, in the deeper gullies *E viminalis* is frequently present and may be locally dominant. Under trees occur here, too, though not in great quantity; both *Banksia marginata* and *Acacia melanoxylon* may assume the stature of small trees. In the undergrowth many of the epacrids and xerophytic *Proteaceae* and such plants as *Tetratheca, Hibbertia,* and others are absent or very much reduced in quantity. Their place is taken by *Dodonaea viscosa, Acacia verniciflua,* and many smaller plants, often broad-leaved, as *Senecio hypoleucus, Goodenia ovata, Spyridium parvifolium,* and *Correa speciosa,* with often very large quantities of *Pultenaea daphnoides,* which locally may form pure thickets. *Acacia myrtifolia* is very abundant, especially on broken rocky ground. *A. retinodes,* though mainly a stream-side plant, may spread out into the forest. Besides these, other characteristic plants are *Lepidosperma laterale, Hardenbergia monophylla,* with its broad shining leaves, and *Rubus parvifolius*. The last is an interesting plant, not only from the point of view of its distribution, but further because it is almost a true deciduous plant. *Pteridium aquilinum* is frequently very abundant in the gullies, becoming locally a dominant plant of the ground layer. This plant has here a much more xerophytic form than the bracken of N.W. Europe. It has evergreen leaves which are hard in texture with narrower, more distant, and entire segments. Its leaves, too, are almost glabrous on the upper surface and much less markedly deltoid. Another very common fern is *Cheilanthes tenuifolia*. In the gully forests there are also a considerable number of herbaceous plants which take a much more prominent part in the plant cover than is the case in the open. Among them

mention can only be made of a few: *Carex Gunniana, Acaena sanguisorbae, Geranium pilosum, Epilobium glabellum, Hydrocotyle hirta, Wilsonia rotundifolia, Helichrysum apiculatum*, and *H. lucidum*. *Adiantum aethiopicum* is a frequent plant on the ground, at times forming a carpet among mosses between the woody plants. *Asplenium flabellifolium* and *Gymnogramme leptophylla* are frequent on moist rock ledges, while *Pleurosorus rutaefolius* occurs on the drier rocks. *Blechnum discolor*, and occasionally *B. capense*, occur on moist rocks by waterfalls, and edge the banks of the streams.

Though many of the more xerophytic types occur also in the gullies the flora, as a whole, has a different appearance. It is greener and less sombre in appearance. Many of the herbaceous plants are quite mesophytic, or even hygrophytic. These, however, only flourish in the Winter and Spring, and become dried up later. The summer herbs are either very low-growing, as *Wilsonia* and *Hydrocotyle*, or are very hairy, as *Helichrysum*.

The distribution of these plants in the gullies varies greatly according to the aspect, the physiography, and other factors. The relation of the slopes towards the sun has a striking effect; the side of a gully receiving direct insolation has a much more xerophytic flora than that which is sheltered. Some plants show a most marked avoidance of direct sunlight, for example *Senecio hypoleucus*, which is often exceedingly abundant in the south facing slopes and entirely absent from the opposite ones. The mesophytic herbaceous flora only attains its full development in the most sheltered and moist situations, as on rock ridges and on banks just above the stream channel.

Except in the narrowest and most steep-sided gullies the flora described, which we may term the "gully flora," has a range restricted to the lower portions of the slopes. The limit of *Pteridium*, for example, often follows a contour line along the gully with considerable exactitude.

Gullies through Glacial Drift

A few of the streams draining that part of the watershed which is covered by drift have cut channels sufficiently deep to be termed gullies. These have a vegetation that is strikingly different from the surrounding scrub; trees of *Eucalyptus obliqua* occur which are quite absent in the open (pl. xiii., fig. 2). On the slopes here occur large quantities of *Pultenaea daphnoides* and *Goodenia ovata* along with *Melaleuca decussata, Marianthus bignoniaceus*, and *Pteridium aquilinum*, but most of the more striking members of the gully flora proper are absent. At the heads of some of the gullies the drift has been removed by erosion, and on the exposed rock there are developed gully forests of *Eucalyptus fasciculosa*, in which the chief plants of the undergrowth are *Acacia myrtifolia, Goodenia ovata*, and *Xanthorrhoea semiplana*. These three plants compose about 80 per cent. of the undergrowth here.

Stream-side Communities.

Along the stream itself in the gullies there is developed a quite characteristic flora which, though ecologically separate from the forest, may be described at this point on account of their geographic relations.

Along rocky streams the characteristic plants are *Leptospermum lanigerum* and *Callistemon salignus*, which form thickets, 8-10 feet high in places, either lining a wide channel or completely covering a small one. These thickets are a striking feature, in summer especially, owing to the pale, almost white, colour of the young hairy leaves of the *Leptospermum*. Along with these two bushes there occurs *Acacia retinodes*, while below and among them are a number of smaller plants, as *Goodenia ovata, G. amplexans, Carex tereticaulis, Juncus pallidus*, and others.

In the case of the larger streams, where permanent pools of water occur, *Typha angustifolia* is plentiful. This occurs often alone, but is sometimes associated with *Phragmites communis*. *Cyperus vaginatus* is another common plant in stream beds which dry up in summer; it is especially abundant on sandy soils.

By springs on rocky soils, or where the stream flows over gravel or stones, a thicket of *Leptospermum lanigerum* and *Acacia retinodes* occurs in which the tall *Gahnia trifida* is very abundant. *Logania lanceolata* occurs locally here, though its more usual habitat is on wet sheltered rocks.

In those valleys where the stream becomes partially held up and the ground is swampy, at any rate during the Winter, *Phragmites* (often along with *Typha*) becomes abundant, associated with *Gahnia psittacorum* (pl. xiv., fig. 1). These plants build up a peat-like soil in which flourish *Blechnum capense*, *B. discolor*, and rarely, *Todea barbara*. The bushes occur largely towards the margins of such a swampy channel. Besides *Leptospermum lanigerum*, there occur *L. scoparium*, *Viminaria denudata*, and *Acacia verticillata*, all of which are very characteristic of this habitat.

In a few cases the gully has a flat bottom covered with silt or sand from the stream, and liable to be flooded in Winter. Where this occurs *E. rubida* is not infrequent along with or replacing *E. viminalis*. In the wetter portions of such valleys there is a thicket-like growth of *Leptospermum lanigerum*, with *L. scoparium*, *Acacia retinodes*, and *Viminaria denudata*, with *Gahnia psittacorum*, *Carex tereticaulis*, *Goodena ovata*, and a considerable number of smaller plants, among which may be mentioned *Juncus planifolius*, *Carex Gaudichaudiana*, *Rubus parvifolius*, with many others. These valleys are generally of small size. Larger swamp areas, where the ground water is more or less stagnant and the soil somewhat peaty, occupy locally not inconsiderable areas, but are developed and exist under conditions so different from those in the forest that they will be considered separately later.

"Box" (Eucalyptus elaeophora) Forests.

Forests allied to those of stringybark both in flora and in general form, but dominated by *Eucalyptus elaeophora*, the "bastard box" or the "peppermint," occur on the more northern part of the ranges. These forests extend a short distance southwards from the line of the gorge cut through by the River Torrens. They occur on hills composed of hard rocks, mostly of Pre-Cambrian age. These rocks are almost all highly metamorphosed and consist of hard schists, crystalline quartzites, or gneiss. They form hills with somewhat rugged outlines and produce shallow stony soils which are relatively fine-grained but not sandy.

The dominant tree, *E. elaeophora*, is generally small in stature and has a great tendency to develop a "mallee"-like habit with two or more stems arising from the base (pl. xiv., fig. 2). Trees, however, of 60-70 feet in height have been noted. This tree reproduces very readily from seed and from stools after cutting. The juvenile foliage, whether of seedling or of coppice shoot, is exceedingly characteristic; the leaves are large, sessile, round, and very glaucous. Both colour and shape are in marked contrast to the adult foliage, and indeed very different from the foliage of any of the other eucalypts of the district. They form a most conspicuous feature of these forests, and recall in some ways the juvenile state of *E. globulus*.

Over the greater part of the area occupied by the "box" forests which we have examined the dominant *E. elaeophora* occurs alone as a pure forest. In the more rocky parts, however, *E. fasciculosa* forms a subsidiary or under tree, not one competing for dominance. *Casuarina stricta* occurs locally on rocky slopes where the soil is scanty.

The similarity of the undergrowth of these forests to that occurring in the stringybark forests is very marked; more especially is this the case with the drier stringybark forests. The chief differences, indeed, are in the absence of many species that occur in those previously described. The main plants of the undergrowth are *Hakea rostrata, H. ulicina, Leucopogon virgatum, Acrotriche serrulata, Astroloma Sonderi, A. humifusa, Tetratheca ericifolia, Platylobium obtusangulum, Xanthorrhoea semiplana,* and *Lepidosperma semiteres. Casuarina distyla* occurs occasionally, but was nowhere seen as an abundant plant. Two facies occur in this undergrowth; in the one case the Epacrids and Hakeas form the bulk of the flora, while in the other *Lepidosperma semiteres* becomes exceedingly abundant (pl. xv., fig. 1), giving the appearance from a distance of a grassy undergrowth. The smaller associated plants are also those of the stringybark forests, *e.g., Scaevola microcarpa, Brunonia australis, Helichrysum apiculatum, Halorrhagis tetragyna, H. ceratophylla, Drosera Menziesii, Danthonia penicillata, Dichelachne sciurea, Dichopogon strictus,* and others.

On the lower slopes a sparser and more open undergrowth is present, in which *Acacia pycnantha* may be present in some quantity along with *Hibbertia sericea, Olearia tubuliflora, Halorrhagis tetragyna, Astroloma humifusa, Goodenia geniculata, Danthonia penicillata,* and others. This flora is very much like that already described for the *E. obliqua* forests at the lower levels On very steep rocky slopes, again, woodlands almost exactly like those already described occur which are composed of either *E. fasciculosa* or *Casuarina stricta* and *Xanthorrhoea quadrangulata. E. elaeophora,* however, appears able to grow and to hold its own on more rocky and shallower soils than does *E. obliqua,* and frequently occurs along with the pink gum. The gullies and valleys cut out in these rocks are, for the most part, wider and more open than those in the Cambrian series of rocks and the characteristic gully flora is not much developed. In some cases, however, as, for example, in the gorge of the River Torrens, the undergrowth is characterised by quantities of *Correa speciosa* which may assume dominance in the second layer. *Senecio hypoleucus,* again, is very abundant on steep rocky slopes facing south. By the streams themselves, which, however, are few in number, exactly the same stream-side flora occurs as in the forests already described. Indeed, the relations of the two types of forest are evidently very close indeed. They have not only closely similar floras, but they occur on corresponding situations, *E. obliqua* forests on the Cambrian quartzites and *E. elaeophora* forests on the metamorphic rocks of Pre-Cambrian age The differences in flora all point in the direction of there being less water available in the forests of *E. eleaeophora.* The importance of this factor of drought is further emphasised by the reported presence of *E. obliqua* in some of the gullies. We ourselves have not seen an actual example of this, but are informed of it by residents in the district who are certainly able to differentiate between the two trees. It has already been noted that in gullies in the dwarf scrub region at Mount Compass *E. obliqua* trees occur, so that the relations of the box forests on the one hand, and the scrub on the other, to the stringybark would appear quite parallel.

The increased dryness is not the result of a decrease in rainfall; nearly all the Precambrian "massif" lies within the 30-inch line and some reaches 35 inches. But the part of the ranges on which the box forests occur is further removed from the sea, and it may be expected that less moisture is brought by the southwest winds. It is certainly noticeable that in Winter mists on the ranges are more frequent from Mount Lofty southwards than they are further north. This decrease in mist and cloud inducing a drier atmosphere on these very shallow silicious soils would appear to be a differentiating factor between forests of *E. elaeophora* and *E. obliqua.* Another factor that may enter into the question

is that *E. obliqua* is here at the western limit of its geographical range. It is well known that many species are much more exacting in their habitat requirements under such conditions. The elucidation of the exact differentiating factors separating the two forests which are undoubtedly very closely allied can only be made complete by detailed quantitative work in the field. It is a question that demands attention not solely from its scientific interest, but also from the practical standpoint. *E. obliqua* is a relatively valuable timber tree, while *E. elaeophora,* being smaller and slow growing, is much less profitable. It might well be advisable to make some attempt to conserve or even increase the area of the former. But with the data at present available it is not possible to go further into the matter.

2. Blue Gum (Eucalyptus leucoxylon) Forests.

Forests of the blue gum, *E. leucoxylon,* cover for the most part the lower hills, foothills, and rolling country on either flank of the main range. They occur on soils formed from slates, phyllites, schists, and limestones of the Cambrian series which lie within the region of 25-35 inch annual rainfall Most of this country has between 27 and 30 inches. The soils vary considerably in composition but are all relatively deep and fine-grained, not sandy. As compared with the soils derived from quartzites or Precambrian rocks they are relatively rich in bases. The topographic features are also different in relation to the softer rocks; the slopes are much less steep and not rugged, the contours and general outlines are rounded (pl. xv., fig. 2).

The forests that occur on these soils are of a very different type from those described above. The canopy is even more open; in many cases, indeed, the trees stand quite apart from one another, giving a park-like effect. The ground vegetation is essentially herbaceous and grass-like in general appearance.

The characteristic tree is *E. leucoxylon,* the blue gum, which, with its white stems and open growth stands out in strong contrast to the stringybark even at long distances. Besides the blue gum, *E. viminalis,* manna gum, is frequent, especially in the regions of higher rainfall and in gullies. *E. rubida,* white gum, occurs in valleys, but is local, and its distribution is considered later. The red gum, *E. rostrata,* though, strictly speaking, a tree of the valley bottoms, frequently spreads out into the blue gum forests. *Casuarina stricta* occurs scattered through the forests and becomes abundant or even locally dominant where the rock is near the surface. This tree is much more abundant in these forests than it is in those of stringybark.

Undershrubs are not generally conspicuous and practically never form a continuous layer. *Acacia pycnantha* is the most prominent, and is never absent except in the regions of lowest rainfall (pl. xvi., fig. 1). This plant is at times very abundant, forming an almost continuous layer, but this condition seems always the result of modification. The plant is encouraged and at times sown owing to its value for bark. It is treated in some of the woods in a manner quite analogous to the encouragement of hazel in oak woods in Britain. Other shrubs which occur here are *Olearia tubuliflora,* the parasitic *Exocarpus cupressiformis,* with *Xanthorrhoea semiplana, Dodonaea viscosa, Bursaria spinosa,* and others more locally.

As mentioned the ground vegetation is herbaceous, but its grass-like appearance disappears on closer examination; true grasses form quite a small proportion of the plant population, which consists of a variety of dwarf shrubs, herbs, and annuals. The form of the ground cover is in marked contrast to that in the stringybark forest, a contrast that is further emphasised by the fact that here the vegetation is largely seasonal. With the exception of some of the shrubby species the whole become dried up in the summer season. Among the most abundant

and generally distributed plants are: *Hibbertia acicularis* and *H. sericea*, which together form the major portion of the cover in Winter. Along with these are *Astroloma humifusa, Acrotriche serrulata*, and, more locally, *Tetratheca ericifolia, Daviesia corymbosa, D. ulicina, Dillwynia hispida, Leptospermum myrsinoides*, and others. These are all shrubby, and along with and sometimes to the exclusion of them occur numerous herbaceous plants, among which may be mentioned: *Leptorrhynchus squamatus, Vittadinia australis, Helichrysum apiculatum, Cymbonotus Lawsonianus, Scaevola microcarpa, Goodenia geniculata, Velleya paradoxa* (local), *Brunonia australis, Halorrhagis tetragyna, H. ceratophylla, H. teucrioides, Linum marginale, Acaena ovina, Caesia vittata, Bulbine bulbosa, Dichopogon strictus, Anguillaria dioica, Schoenus apogon, Carex breviculmis, Themeda triandra, Danthonia penicillata, Stipa scabra, S. eremophila, S. semibarbata.* Of these *Acaena ovina* is generally very abundant, and along with *Danthonia, Leptorrhynchus*, and *Scaevola* forms a large part of the herbaceous flora. Other plants common but rather less abundant are *Convolvulus erubescens, Ajuga australis, Eryngium rostratum*, and others. Orchids occur in some variety in these forests, especially in the moister parts. Among the commoner are *Diuris longifolia, D. pedunculata, Thelymitra aristata, Corysanthes fimbriata, Pterostylis nana, P. nutans, Acianthus exsertus, Caladenia deformis, C. carnea.*

These open forests have been invaded, to a much greater extent than occurs in those described above, by alien plants. Some of these have now come to occupy a definite place in the vegetation and have penetrated far beyond the region of direct interference by man. The most noteworthy are three annual grasses: *Briza maxima, B. minor*, and *Aira caryophyllea*, while *Bromus maximus* is a little more restricted.

Annuals generally are abundant. Very generally distributed species are: *Flaveria australasica, Brachycome diversifolia, B. trachycarpa, Lagenophora Billardieri, Helichrysum scorpioides, Sebaea ovata*, and *Wahlenbergia gracilis.* In valleys and places where the soil is wet in Winter and Spring a number of ephemeral annuals occur, *e.g., Brizula pumilio, Centrolepis aristata, Hydrocotyle callicarpa*, and *Rutidosis pumilo*, with several others.

Parasites, and especially *Loranthus Miquelii*, are abundant. *L. Miquelii*, indeed, may be so abundant that trees of *E. leucoxylon* may be much impoverished or even killed out. *L. exocarpi* is less common. *Cassytha melantha* occurs locally in great quantity.

In these blue gum forests the distribution of the undergrowth varies a good deal with changes in topography and soil. On the lower slopes and on northern exposures the larger shrubs are almost absent, the flora being composed of *Hibbertia* with herbaceous plants and grasses. Geophytes, for example *Microseris Forsteri, Drosera Whittakeri*, many Liliaceae and orchids, are only abundant in sheltered situations which are moist in the Spring. Slopes with a southern exposure often abound in shrubs, especially *Acacia pycnantha*, while on the ground *Cheilanthes tenuifolia* is prominent, and *Pteridium aquilinum* may approach dominance towards the bottoms of valleys. On ridges running east and west there is often a marked difference in the flora on the two sides; that facing north has few or no shrubs and a ground cover which is essentially herbaceous and becomes quite burnt up and brown in summer, while on the opposite slope, facing south, the trees are closer together, *E. viminalis* often occurs along with *E. leucoxylon*, and a more or less definite layer of *Acacia pycnantha*, with some *Exocarpus* and *Bursaria spinosa*, is present. On the ground are many geophytes and *Cheilanthes tenuifolia;* these dry up in summer, but do so much more slowly, and the vegetation through most of the year appears much less parched.

On the tops of broader ridges and in relatively level parts *Acacia pycnantha* becomes especially abundant. On the uppermost ridges, which have a shallower soil and which are liable to a longer and more frequent drought, a more xerophytic facies in the ground flora occurs. Many undershrubs are present, such as *Hibbertia, Tetratheca, Astroloma,* and *Acrotriche.* In parts of the ranges there are steep rocky slopes on which *Casuarina stricta* is abundant, sometimes to the exclusion of Eucalypts. With it occur some quantities of *Xanthorrhoea quadrangulata* and *X. semiplana.* Such slopes form a locality for *Callitris cupressiformis,* var. *tasmanica.* This plant, which forms a bush rather than a tree, is not generally distributed, but usually occurs in circumscribed groups in which the individuals may be close together and exclude other vegetation. At other times the *Callitris* bushes are separated from one another.

Owing to the open character and to the type of undergrowth these forests of *E. leucoxylon* are less liable to damage by fire than are those of *E. obliqua.* Fires do occur from time to time, though their effects are much less pronounced Occurring as they do in the Summer, when most of the ground plants are dormant, little damage is done and, owing to the absence of shrubby undergrowth, the trees are rarely affected. Fires apparently assist the spread and seeding of *Callitris.* In those portions where *Acacia pycnantha* is abundant a bush fire has a more marked result. *Acacia* is a plant whose germination is stimulated by fire, and afterwards it appears in increased quantity. Immediately following the fire *Ixodia achilleoides* becomes temporarily abundant, though to a much less extent than it does in the stringybark forests.

In some parts forests of blue gum adjoin those of stringybark. Where this occurs the transition from one to the other may be abrupt or more gradual. The former case is especially striking, a sharp line dividing the two; on the one side *E. obliqua,* with its dark stems and dense xerophytic shrubby undergrowth, and on the other the white stems of the *E. leucoxylon,* with the herbaceous ground cover. But while this abrupt transition does occur, in very many cases there is a zone of mixed forest that may be many yards across. This mixed forest has a rather open undergrowth, with *Acacia pycnantha, Hibbertia acicularis, Tetratheca ericifolia, Leucopogon virgatum,* and others as the most prominent plants.

In the region studied where the rainfall is rather high the determining factor differentiating the two types of forest is edaphic, but other factors must also be recognised, as will be shown later when the relationships of the communities are discussed.

Ironstone Soils.

The rather basic soils upon which blue gum forests grow may become impregnated with iron just as occurs with the quartzites. The ironstone is, however, less common and occurs over less extended areas. The ironstone is either in the soil or subsoil, or else the rock itself is an ironstone, in which case a very shallow soil results. In either case the flora changes and a more xerophytic facies occurs which comprises a much greater number of shrubby plants. Undershrubs, indeed, may become dominant and an undergrowth occurs which is very similar to that of the stringybark forest.

Where there is an ironstone soil heath-like undershrubs become abundant; the most prominent are *Grevillea lavandulacea, Leucopogon virgatum, Acrotriche serrulata, Leptospermum myrsinoides, Tetratheca ericifolia,* along with *Hibbertia acicularis, H. sericea,* and *Xanthorrhoea semiplana.* Locally taller undershrubs occur, such as *Hakea ulicina, Casuarina distyla, Astroloma Sonderi,* and others. *Acacia pycnantha* is here scarce and annuals, like many of the herbaceous plants, are much less abundant or absent.

On the very shallow soils formed from the ironstone rock the trees are small and stand at long distances apart. The trees here are very much infested with *Loranthus Miquelii*, which is rarely absent from any approaching maturity. The undergrowth is a rather dense scrub of bushes rising 2-4 feet; *Casuarina distyla* is the most abundant, but with it occur considerable quantities of *Xanthorrhoea semiplana, Hakea rugosa, H. ulicina, Isopogon ceratophyllus, Calythrix tetragona, Leptospermum myrsinoides, Lissanthe strigosa,* and others. Among these shrubs occur *Neurachne alopecuroides, Helichrysum Baxteri, H. scorpioides, Leptorrhynchus squamatus, Kennedya prostrata,* and other small plants. This undergrowth is very much like that which occurs in the stringybark forest on ironstone, but has several points of difference: *Hakea rugosa* takes the place of *H. rostrata*, many plants of the stringybark forest are missing, and some others are here more prominent.

These ironstone areas with their shrubby xerophytic undergrowth are much affected by fires. After burning, flowering and increase of *Xanthorrhoea semiplana* occurs just as was described earlier; *Ixodia achilleoides*, however, is here quite a local plant. A considerable number of small plants become much more prominent after a fire, though none of them become very abundant; among them are *Stipa eremophila, Danthonia penicillata,* and *Helichrysum Baxteri*. The orchid *Lyperanthus nigricans* which occurs here seems only able to produce flowers after a fire. Among the shrubs *Calythrix* and *Leptospermum* increase after burning, both from seed and owing to their rapid regeneration

Gully Forests.

The gully and stream-side forests, which are such a feature of the watercourses in quartzite rocks, are here poorly developed owing to the softer rock giving a different topography. The flat bottoms of the larger valleys are occupied by woodlands of *Eucalyptus rostrata*, which are described later separately. On valley sides the flora is often hardly distinct from that described above. *E. viminalis* is generally more abundant. Where shelter is obtained shrubs are more abundant, especially *Acacia pycnantha*, with *Bursaria spinosa* and *Dodonaea viscosa*. *Banksia marginata* is here almost entirely a valley plant. Among characteristic ground plants in the moister places are *Arthropodium paniculatum, Carex Gunniana, Juncus pallidus, Goodenia amplexans* and *G. ovata*, and others.

Savannah Forest.

On the somewhat undulating country on the east side of the ranges there occurs a savannah-like forest that differs in some ways from the blue gum forests described above. The trees here form a very open forest; they stand isolated or in groups with many clear spaces and glades. The trees are principally *E. leucoxylon* and *E. viminalis* (pl. xvi., fig. 2). *E. rostrata* occurs in the valleys but extends out from them to a considerable extent, often becoming mixed with the other species. *Casuarina stricta* grows on rocky outcrops. *E. leucoxylon* occurs here in two forms, the common white-flowered plant and one with red flowers, which apparently does not differ in other respects. Shrubs are almost wholly absent from these woods; a few scattered plants of *Acacia pycnantha* occur which sometimes rise to the stature of small trees, but these are never at all abundant.

The ground flora is herbaceous and grass-like; it becomes very much dried up and burnt yellow in Summer. The most abundant plants are *Acaena ovina, Danthonia penicillata, D. carphoides, Stipa scabra, S. eremophila,* and *Vittadinia australis*, with several others in less quantity, as *Hibbertia sericea, Pimelea glauca, P. humilis, Astroloma humifusa, Wahlenbergia gracilis, Convolvulus erubescens,*

Leptorrhynchus squamatus, Dichopogon strictus, and *Bulbine bulbosa.* Much less abundant but very generally distributed plants are: *Flaveria australasica, Lagenophora Billardieri, Brachycome trachycarpa, Hypericum japonicum,* and *Halorrhagis tetragyna.*

On the rocky outcrops, on which *Casuarina* occurs to the exclusion of the Eucalypts, the undergrowth is very sparse but of the same character. A few plants such as *Halorrhagis ceratophylla, Scaevola microcarpa,* and stunted *Cheilanthes tenuifolia* occur here, but not in the general woodland.

Practically the same flora occurs in the open valleys under the trees of *E. rostrata.* In addition to the plants named, isolated clumps of *Juncus pallidus,* which may reach a very considerable size, occur; *Schoenus apogon* and *Drosera peltata* are locally abundant. Several moisture-loving ephemerals grow here, among which may be mentioned *Centrolepis aristata, Drosera glanduligera, Hydrocotyle callicarpa,* and others.

In some parts deeper valleys have been cut out, and in these there is a richer flora *Leptospermum myrsinoides* may be abundant, and along with it *Acacia obliqua, Thomasia petalocalyx, Grevillea lavandulacea, Bursaria spinosa, Trichinium erubescens,* and others may be found. Locally *Xanthorrhoea semiplana, Lepidosperma semiteres,* and *L. viscosum* occur in some quantity along with *Lomandra (Xerotes) dura,* and others. Where the trees have been felled some of these plants, and especially *Lepidosperma,* may become exceedingly abundant, so much so indeed as almost to exclude the grassy undergrowth.

3. Manna Gum (Eucalyptus viminalis) Forests.

Forests composed of *E. viminalis,* manna gum, either alone or with some admixture of other species, occur rather locally in valleys and on gentle slopes where the soil is a deep and loose and rather fine-grained sand. The forests on sand are rather open in character, with *E. viminalis* as almost the only tree species. *E. rostrata* may be present in the bottoms of the valleys, and occasional trees of *E. leucoxylon* occur on the slopes. *Banksia marginata* is abundant here as an under tree and in open spaces, or when trees have been cut out, may form quite dense thickets. Otherwise the undergrowth is composed of dwarf shrubs and herbs Of the undershrubs Hibbertias are much the most abundant, *H. sericea, H. virgata,* and *H. stricta* are common, while *H. acicularis* is occasional. Other plants are *Leptospermum myrsinoides, Isopogon ceratophyllus, Platylobium obtusangulum, Dillwynia hispida, Tetratheca ericifolia,* and others. These shrubs form an open cover, standing at some distance apart from one another, and not or very rarely in contact. Among the most prominent of the herbaceous and smaller plants that occupy the spaces are *Stipa scabra, Lepidosperma carphoides, Helichrysum scorpioides, H. Blandowskianum, Brunonia australis,* and others. These manna gum woodlands on sandy soils show a fairly rapid power of regeneration; young trees are of frequent occurrence, and after cutting or ringbarking the forest is soon re-established if left undisturbed. After cutting, *Banksia* spreads very rapidly for a time, but soon becomes subsidiary to the stronger-growing taller Eucalypts. However, should an almost continuous layer of *Banksia* occur in these woods it can be taken as evidence of previous interference with the tree canopy.

E. viminalis also forms pure woodlands on another type of habitat, namely, towards the head of some of the gullies running into the hills. Here the woods occur just below the region of the stringybark forests. Such local forests represent what is apparently a gully forest of the blue gum type. Occasional trees of *E. leucoxylon* are present, and also some of *E. obliqua,* in the upper parts. Under trees and bushes are scattered, and do not form a continuous layer; *Acacia*

melanoxylon, A. pycnantha, Bursaria spinosa, Dodonaea viscosa, and *Banksia marginata* are the chief plants. The undergrowth is generally herbaceous, *Cheilanthes tenuifolia* is abundant, along with *Danthonia penicillata, Stipa scabra, Bulbine bulbosa, Ajuga australis,* with *Pteridium aquilinum* very abundant or even dominant towards the bottom of the slope. On very sheltered, steep, south-facing slopes *Acrotriche fasciculiflora* may be abundant or even locally dominant. Bryophytes are generally prominent in these woods.

The forests of *E. viminalis* are closely allied both in structure and flora to those of *E. leucoxylon.* The main difference appears due to increased moisture, in the first type described (that on deep fine sands) to moisture in the soil and in the second to moisture due to the shelter of a gully. As has been noticed, *E. viminalis* is commonly associated with *E. leucoxylon,* and it appears to become the dominant to the exclusion of the latter under moister conditions.

4. White Gum (Eucalyptus rubida) Forests.

E. rubida, white gum or "candlebark," locally forms almost or quite pure forests on parts of the hills where the rainfall is 30 inches or more. The ground is undulating, with small valleys between low ridges. The white gum forests occur at and around the heads of these valleys. The form of the woodland depends to a considerable extent on the age of the trees *E. rubida* is a tree attaining a considerable size, 100-150 feet or more, and when mature is a marked light-demander, so that woodlands composed of old trees are very open, the trees standing at long distances apart. Seedlings and young trees, however, come up in the spaces in great numbers, and quite dense woodlands occur composed of trees with poles of 1-1½ feet diameter *E. rubida* may occur pure or in association with *E. leucoxylon.* Generally in the valley depressions it is in pure stand, but on the slopes the latter tree occurs mixed with it (pl. xvii., fig 1).

Acacia pycnantha occurs in the undergrowth but is not abundant. The ground cover consists of *Hibbertia acicularis* with *Tetratheca ericifolia, Acrotriche serrulata,* and many herbaceous plants; *Pteridium* occurs, but is local, as also is *Leptospermum myrsinoides* The flora is indeed practically that described for the forests of *E. leucoxylon.*

E. rubida is a tree that makes considerable demands on the soil for water. Its presence has already been noted in the stringybark forests by creeks in flat-bottomed valleys. It is a characteristic tree of swamps which will be described later. In the woods just described the abundance of the tree and its spread out from the valleys is correlated with the presence of a water-retaining soil occurring on slight slopes with a high rainfall. Its spread and abundance here have almost certainly been assisted by human interference; *E. leucoxylon* forms a much more valuable timber than *E. rubida,* and preferential cutting undoubtedly assists the spread of the latter both by removal of competition and of trees from which seed for regeneration is supplied. These forests of *E. rubida,* with almost the same flora as those of *E. leucoxylon,* are certainly largely produced semi-artificially in this way. How far and how long they would be able to maintain themselves if left alone cannot at present be stated.

5. Peppermint (Eucalyptus odorata) Forests.

On the foot-hills and on the upper margin of the plains there are forests which have much in common with the blue gum forests, but which are dominated by a wholly different tree, namely, *E. odorata,* peppermint or box (pl. xvii., fig. 2). This is generally a small tree, not often reaching more than 50 feet in height. It has a great tendency to develop several stems from the base and frequently occurs as a large mallee. This tree has a dark bark and dark dull-

green foliage, in both of which characters it forms a strong contrast to *E. leucoxylon.*

At the present time the area occupied by peppermint forests has been very much reduced as compared with the primeval condition. The forests, too, which remain have been in most cases considerably modified by cutting, pasturage, and other human activities.

These forests occur on relatively deep basic soils which have the general feature of being very retentive of water in winter, becoming in many cases more or less waterlogged, while in summer they become baked hard and dry. The soils are very similar to those occupied by the blue gum forests, but are as a rule more friable and less caked in the dry season. It does happen, however, that blue gum forests cover the top of a slope the lower portions of which are clothed by peppermint. *E. odorata* generally forms pure open forests. The tree has great power of regeneration from the stool after cutting, but does not spread from seed rapidly. *Casuarina stricta* occurs scattered through the forest and is abundant in the driest parts where the soil is shallow (pl. xix., fig. 1). Locally on dry sunny slopes small trees of *Pittosporum phillyraeoides* occur, but are never at all numerous. Shrubs are not generally abundant; on the lower drier parts they are often absent, but at higher levels *Acacia pycnantha* is abundant. As in the case of blue gum forests, the plant is in parts encouraged and sown. In not inconsiderable stretches where such sowing has occurred and Eucalypts have been felled the forest has been replaced by a bushland of *Acacia pycnantha.* Other shrubs are of infrequent occurrence.

It may be mentioned here that parasites are not abundant in these forests; *Loranthus* is rather rare on *E. odorata. Cassytha melantha* is quite local and *Exocarpus* is by no means frequent.

The ground vegetation varies considerably in different parts; on slopes where the soil is not often saturated in Winter a considerable variety of herbs make up a cover in which grasses or grass-like plants take a considerable part (pl. xvii., fig. 2). The most abundant tree grasses are *Danthonia penicillata, Stipa scabra,* and *S. eremophila,* together with the ubiquitous introduced grasses *Briza maxima, B. minor, Bromus maximus, Aira caryophyllea,* and *Festuca bromides.* Along with these are *Dichopogon strictus, Burchardia umbellata, Anguillaria dioica,* and, less often, *Bulbine bulbosa.* The most abundant dicotyledons here are *Scaevola microcarpa, Brunonia australis, Leptorrhynchus squamatus, Halorrhagis tetragyna,* and others. The low undershrubs *Hibbertia acicularis, H. sericea, Pimelea glauca,* and *Astroloma humifusa* occur scattered through and are most frequent in the driest spots. In early Summer *Flaveria australasica, Sebaea ovata,* and some other annuals are abundant.

On rather level ground and flats where the soil is saturated through much of the Winter there occurs a flora in which geophytes take a considerable share along with, in Spring, a number of ephemerals. Here *Hibbertia sericea* and *H. stricta* are generally frequent. Of the geophytes the most prominent are *Hypoxis glabella, Chamaescilla corymbosa, Burchardia umbellata, Caesia vittata, Bulbine bulbosa, Caladenia deformis, C. dilatata, C. Patersonii, Diuris pedunculata, D. longifolia,* and other species of orchids, *Drosera Whittakeri, D. peltata, Microseris Forsteri,* and others. Two very interesting geophytes here are the lycopods *Isoetes Drummondii* and *Phylloglossum Drummondii,* which were discovered in South Australia by Osborn, who first described this type of community (1918). Among the ephemerals noticeable forms are *Hydrocotyle callicarpa, Rutidosis pumilo, Quinetia Urvillei, Stylidium calcaratum, S. despectum, Centrolepis aristata, C. strigosa, Brizula pumilio,* and several others. In this community *Schoenus apogon* is abundant and may locally form a turf. In the wettest parts occurs *Polypompholyx tenella.*

On these wet flats the peppermint is mixed with some *E. rostrata* and *E. leucoxylon*, the latter in less quantity (*c.f.* Osborn, 1918, pl. i., fig. 1).

A most complete contrast to this type of forest on the flats is provided by that developed where ironstone is present. The ironstone here forms a "pan"-like layer in the soil and causes a change to a shrubby xerophytic flora in which the following are prominent: *Leptospermum scoparium*, *L. myrsinoides*, *Lissanthe strigosa*, *Astroloma humifusa*, *Hibbertia sericea*, *H. acicularis*, *Olearia tubuliflora*, and others. *Acacia pycnantha* is usually present. When ironstone rock is present *E. leucoxylon* and the type of forest described earlier occurs.

On the lower slopes and on the upper limits of the plains the forests of *E. odorata* have been so modified that the ground flora is composed now wholly of introduced plants which have completely driven out the native species and absorbed their place. These semi-artificial communities are considered later. Remnants of peppermint forests occur extending on to the Adelaide plains, which, probably, were originally covered with open "savannah forests" of this tree. At present the native undergrowth has wholly disappeared and has been replaced by weeds and aliens. In some relics of the forest that still exist near the sea, trees of *Melaleuca parviflora* are present and *Cladium junceum* may be abundant on the ground.

E. odorata forests form a roughly-marked zone at the foot of the ranges, while *E. leucoxylon* forms a zone higher up The line of junction of the two is often quite sharp. The differentiating factors, which are considered more fully later, appear to be partly edaphic and partly climatic. On the Mount Lofty Ranges the climatic zones are so close together and so narrow that the influence of each is somewhat obscured. However, on the hills 50 to 100 miles north of Adelaide the climatic differentiation of the two becomes much more clear. There *E. leucoxylon* forests are confined to the larger hills with a rainfall of 22-25 inches or more, while *E. odorata* clothes the foot-hills and wide valleys which receive less rain.

6. Red Gum (Eucalyptus rostrata) Forests.

The red gum, *E. rostrata*, is one of the most widely-distributed species of *Eucalyptus* in Australia, and also one with very marked characteristics of habitat. It occurs on diverse types of soil, but in all cases in situations where a considerable supply of underground water is present for the roots. It is essentially a riverside and valley bottom tree. In the area under consideration at present, it occurs by rivers and creeks where a moist soil is provided (pl. xviii., fig. 1) and also on flats where water is retained. In the last case quite considerable areas of forest may occur, whereas in the former the red gum grows rather as a fringe along the river or stream. On all the soils described, wherever a broad-bottomed valley or a flat with permanent, or relatively permanent, ground water occurs *E. rostrata* is present. Such situations are found in the flood plains of streams, the upper parts of valleys with slight fall, and the collecting grounds of streams. The soil varies considerably but is typically deep and with a fair proportion of fine-grained constituents. Gravel, however, may be abundant.

E. rostrata becomes a large tree with a spreading habit, and, like so many other members of the genus, is very intolerant of shade. It forms open forests, but, owing to its extremely ready regeneration from seed, a good cover is produced. In untouched forests, wherever a gap occurs, groves of seedlings and small trees appear and form quite dense groves of young trees. *E. rostrata* occurs, as a rule, quite pure. Undertrees are not abundant; *Acacia melanoxylon* is present but only in small amount, *Banksia marginata* is very local. Shrubs are also few both in number and in variety of individuals; *Leptospermum scoparium* is

not infrequent but scattered; *Bursaria spinosa, Dodonaea viscosa, Acacia retinodes,* and others occur locally. The undergrowth is for the most part herbaceous or of small plants. Along stream channels, or in depressions where most water is present, large herbs may grow abundantly, as: *Juncus pallidus, J. polyanthemos, J. pauciflorus, Carex tereticaulis, Gahnia psittacorum,* with *Patersonia longiscapa* in the wettest spots. Other plants are *Goodenia ovata, G amplexans, Acacia spinescens, A. verticillata,* and others. *Villarsia reniformis* occurs in ditches and pools.

The main ground cover consists of small herbaceous plants with many geophytes and ephemerals. The flora, in fact, is very like that mentioned in the *E. odorata* forests on flats. Such plants as *Isoetes Drummondii, Chamaescilla corymbosa, Dichopogon strictus, Schoenus apogon, Drosera Whittakeri, D. auriculata,* and *Hypoxis glabella* may be abundant. Locally *Carex Gaudichaudiana* may form a turf. In those parts, where the surface soil is very dry in Summer, the flora scarcely differs from that of the surrounding woodland Indeed, apart from the absence of shrubs, such as *Acacia pycnantha* and others, very little change occurs in passing from a forest of *E. leucoxylon,* or of *E odorata,* to one of *E. rostrata* by a creek till the creek itself is reached The number of ephemerals increases and a few moisture-loving plants appear, but many of those generally inhabiting drier situations persist. The reason for this rather slight change of flora lies in the fact that the surface layers in which the ground plants are rooted becomes parched in Summer, just as do those of soils without deeper water supplies. The red gum trees penetrate to the deeper water stores, consequently the conditions for the trees and for the herbs are very different in summer time. *E. rostrata,* however, spreads out to some extent from these typical habitats This is especially the case in the rolling "savannah" country to the east of the ranges.

In the more mountainous parts, where the valleys are narrower and have steeper sides, flat alluvial plains are not formed. *E. rostrata* here can hardly be said to form a forest; it grows along the line of the creek wherever any water-holding soil occurs. In the upper regions, where less and less soil is formed, its place is taken by *E rubida* or *E. viminalis.*

In the plains the same relations hold; *E. rostrata* forms forests by streams and on low-lying marshy land. In the Adelaide suburban district, where these situations have been much altered by settlement and forests destroyed, *E. rostrata* is still the commonest indigenous tree.

7. Swamps.

Swamps in which the soil is permanently wet are local, but some good examples occur in the district. They occur on some river flats, in certain hill gullies where water run-off is prevented, and at the head waters of streams rising in the Permo-carboniferous glacial deposits. The soil in these swamps is not only permanently wet, but is in some cases largely or entirely built up of plant remains which form a black rather structureless peat. The more peaty swamps in the hills have had their vegetation largely or completely destroyed on account of the value of the land for the cultivation of fruit and vegetables. There still remain, however, some examples which are almost untouched.

Silt Swamps.

The vegetation in the swamps varies greatly and can be correlated with several factors, among the most striking of which is the presence or absence of inorganic silt in the soil (Pearsall). When the soil is essentially a mineral one, with organic matter diffused through it as humus, trees are present. *E. rubida*

is the chief one (pl. xviii., fig. 2), though *E. rostrata* occurs where the ground water is not stagnant. These trees are scattered and do not grow close enough to form a woodland community. The vegetation other than trees has the form of a dense growth 3-6 feet in height, consisting of *Leptospermum scoparium* with *Acacia retinodes, A. verticillata, Viminaria denudata.* The undergrowth contains a great variety of species, prominent among which may be mentioned: *Patersonia longiscapa, Cladium junceum, C. tetragonum, Schoenus brevifolius, Juncus planifolius, J. pauciflorus, J. holoschoenus,* and *Calamagrostis quadriseta.* Along with these occur *Ranunculus lappaceus, Microseris Forsteri, Chamaescilla corymbosa, Burchardia umbellata.*

Small plants including ephemerals are abundant: *Drosera peltata, D. auriculata, D. Whittakeri, Hydrocotyle callicarpa, Schoenus apogon, Centrolepis aristata, C. strigosa, Microtis atrata, M. parvifolia.* In depressions where the vegetation is not continuous there occur *Drosera pygmaea* and *Stylidium despectum. Centrolepis strigosa* especially may be very abundant. In the driest parts, around bushes, there occurs *Bossiaea prostrata* in some quantity, also *Dillwynia hispida, Halorrhagis tetragyna, Adiantum aethiopicum,* and some others. Here, also, there are small plants of *Hakea ulicina, Banksia marginata, Pimelea glauca,* and some other invaders from forests. Such plants do not seem able to establish themselves completely and die down after reaching a certain quite limited size. They appear to be woodland plants which attain access to the new habitat but find it unsuited to them.

Some examples have been seen in which these silt swamps have been cleared and subsequently abandoned. In this case regeneration of the vegetation occurs rather quickly. At first the community is predominantly herbaceous, the most prominent plants being *Cladium junceum, Juncus planifolius, J. holoschoenus,* and *Patersonia longiscapa.* Associated with these are most of the plants found in the *Leptospermum* swamps; *Centrolepis strigosa* becomes exceedingly abundant along with *Leptorrhynchus squamatus, Carex Gaudichaudiana,* and other plants that occur especially in the more open parts of the mature swamp. A few plants from drier situations penetrate at this stage; notably *Themeda triandra, Poa caespitosa,* and *Kennedya prostrata.* However, seedlings of *Leptospermum, Viminaria,* and *Acacia verticillata* soon appear and rather rapidly assert themselves to reattain dominance over the community.

Peat Swamps.

As a complete contrast to the silt swamp, one with a pure peat soil will next be considered. Good examples are found in the depressions between the low ridges covered with glacial deposits in the Mount Compass region. The largest swamp here is that known as Square Water Hole. The soil here is a peat which is quite black, rather fibrous, but with a soapy feel. The preservation of structure is very poor. This peat may attain a thickness of several feet. The soil is saturated all through the Winter, and even in Summer is quite wet a few inches below the surface. In Winter, indeed, much of the surface is under water, only the highest portions standing out. The vegetation consists of a varied assemblage of plants, among which monocotyledons of rush-like habit predominate. The great mass of it is composed of *Cladium junceum, Schoenus brevifolius, Xyris operculata,* and *Sprengelia incarnata,* with an undergrowth of *Hypolaena lateriflora, H. fastigiata, Leptocarpus Brownii,* and *Lepidobolus drapetocoleus.* In the drier, more elevated portions *Lepidosperma exaltatum, Leptospermum scoparium,* and *Epacris impressa* become abundant. This swamp provides the habitat for a number of interesting plants, among which mention may be made of *Lycopodium laterale, L. carolinianum, Schizaea fistulosa, Lindsaya linearis, Utricularia lateriflora,* and *Levenhookia dubia.*

A moderately complete story of the building up of surface peat in this type of swamp can be made out. Starting from hollows that are bare peat and under water all Winter, we can trace the development to the driest parts where *Leptospermum scoparium* flourishes. The first plants to appear on the bare peat are *Microtis atrata, Levenhookia dubia, Utricularia lateriflora,* and *Selaginella Preissiana.* These plants, however, take no part in peat building. They flourish on the very wet bare portions. The pioneer in building up of peat is *Chorizandra cnodis,* which fixes and raises the surface. After a time *Chorizandra* becomes mixed with and finally suppressed by *Cladium junceum.* As soon as a more solid surface is formed other plants appear. Among the first are *Hypolaena lateriflora, H. fastigiata, Leptocarpus,* and *Lepidobolus,* with *Lycopodium laterale* and *Sprengelia incarnata. Lycopodium carolinianum* flourishes best when the peat building is rather slow. As the surface becomes raised *Sprengelia* becomes more and more abundant and approaches dominance in association with *Xyris operculata* and *Epacris,* while the Restionaceae become more or less suppressed. These plants in turn gradually give way to *Leptospermum scoparium,* which is associated with *Lepidosperma exaltatum.*

By the drainage channels the succession is somewhat different. *Patersonia* and *Lepidosperma* spp. commence except in very large channels where *Phragmites* is present. These are followed by *Cladium tetragonum* with tufts of *Gahnia psittacorum,* which are in turn ousted by *Leptospermum scoparium,* with *Acacia retinodes* and *Viminaria denudata.* The successions outlined here are the general sequence, but frequent local variations and modifications occur which cannot be detailed here.

Round the margins of the swamps the peat is thinner, it becomes much drier in summer, and is more mixed with mineral matter. The vegetation, too, is considerably changed as compared with the central parts; *Sprengelia* is much less abundant, as also are the pteridophytes. *Hypolaena fastigiata* becomes very prominent, far more so than *H. lateriflora,* and is associated with *Epacris, Cladium glomeratum,* and, locally, large quantities of *Leptocarpus Brownii.*

Peaty-silt Swamps at Gully Heads.

The swamps that occur at or near the heads of some of the gullies in the hills are in some ways intermediate between the two types described above. The soil is a black peat which, however, contains a considerable mixture of rather fine inorganic silt. This peat is quite structreless and without the fibrous character of the pure peats. The soil here is less wet than that of the pure peats—even in Winter the surface is not submerged; on the other hand, in Summer, more water is retained than in the silt swamp soils.

Trees are absent here from the swamp proper, though *E. rubida,* and occasionally *E. viminalis,* occur round the margins. The main vegetation is composed of *Leptospermum scoparium* with *Acacia retinodes* along channels. *Sprengelia incarnata* occurs abundantly, for the most part between the bushes of *Leptospermum.* The undergrowth consists of a variety of herbs, generally of small size, amongst which *Hypolaena lateriflora, Cladium tetragonum, Schoenus apogon, Centrolepis strigosa, Drosera binata,* and *Halorrhagis parviflora* are abundant. Other noticeable plants are *Utricularia dichotoma* and *Microtis parvifolia.* Local large tufts of *Gahnia psittacorum* are present, and *Cladium glomeratum* is frequent. In the drier parts, around and beneath the bushes, *Lindsaya linearis* is very abundant. *Gleichenia circinata* forms great masses along the banks of drainage channels, when it locally excludes all other plants; *Blechnum discolor* also occurs along channels.

Under thickets of *Acacia retinodes,* where the shade is rather dense, the ground plants are rather scattered; the most abundant are *Drosera binata,*

Villarsia reniformis, Gratiola peruviana, and *Scirpus inundatus.* Along the outflow stream channel *Phragmites communis* is abundant, along with *Gahnia trifida, Leptospermum scoparium,* and, locally, *Viminaria denudata.*

The following lists of the species observed in examples of swamps of the three types described above will show the relationships of these and also bring out some of the differences between them.

Analysis of Swamp Floras.

In the lists below the occurrence only of the plants is recorded. No attempt has been made to give relative frequencies. This is done for two reasons: first, the lists are not of simple communities, but cover a number of stages of the development, and so frequencies, if given, could not give a true picture of the vegetation; secondly, the lists are certainly far from complete.

These lists contain those plants actually seen by us in the three localities specified. They are not composite lists made up from a number of different places:—

List of Plants of Swamps.

	A Silt Soil. Mylor	B Silt with Peat Smith's Swamp, near Mylor.	C. Peat Soil Square Water-hole.
Lindsaya linearis, Sw.		+	+
Adiantum aethiopicum, L.	+		
Blechnum discolor, Keys.		+	
B. capense, Schlecht.		+	
Gleichenia circinata, Sw.		+	
Schizaea fistulosa, Labill.			+
Lycopodium carolinianum, L.			+
L. laterale, R. Br.			+
Selaginella Preissiana, Spreng.			+
Themeda triandra, Forsk.	+		
Calamagrostis quadriseta, Spreng.	+		
Danthonia penicillata, F. v. M.	+		
Briza minor, L.	+		
B. maxima, L.	+		
Poa caespitosa, Forst.	+	+	
Cyperus tenellus, L. f.	+	+	
C. rotundus, L.		+	
Schoenus axillaris, Poir.		+	
S. apogon, R. & S.	+	+	
S. brevifolius, R. Br.			+
Scirpus setaceus, L.		+	+
S. stellatus, C. B. C.		+	
S. inundatus, Poir.		+	
Chorizandra enodis, Nees.			+
Cladium junceum, R. Br.	+	+	+
C. glomeratum, R. Br.	+	+	+
C. tetragonum, J. M. Bl.		+	+
Gahnia trifida, Labill.		+	
G. psittacorum, Labill.		+	+
Lepidosperma exaltatum, R. Br.		+	+
L. semiteres, F. v. M.	+		
Carex appressa, R. Br.		+	
C. Gaudichaudiana, Kunth.	+		
Leptocarpus tenax, R. Br.			+
L. Brownii, Hook. f.			+
Hypolaena lateriflora, Benth.		+	+
H. fastigiata, R. Br.			+
Lepidobolus drapetocoleus, F. v. M.			+
Brizula gracilis, Hieron.		+	
Centrolepis aristata, R. & S.	+		+
C. fascicularis, Labill.		+	
C. strigosa, R. & S.	+	+	+
Xyris operculata, Labill.			+

	A. Silt Soil. Mylor.	B. Silt with Peat. Smith's Swamp, near Mylor.	C. Peat Soil. Square Waterhole.
Juncus capitatus, Weig.	+		
J. bufonius, L.	+		
J. planifolius, R. Br.	+	+	
J. holoschoenus, R. Br.	+	+	
J. pallidus, R. Br.	+		
J. pauciflorus, R. Br.	+		
J. polyanthemus, Buch.	+		
Burchardia umbellata, R. Br.	+	+	
Chamaescilla corymbosa, F. v. M.	+	+	+
Bartlingia sessiliflora, F. v. M.		+	
Hypoxis glabella, R. Br.	+		
Patersonia longiscapa, Sweet.	+	+	+
P. glauca, R. Br.			+
Microtis porrifolia, Spreng.		+	
M. atrata, Lindl.	+		+
Caladenia carnea, R. Br.		+	
Diuris palustris, Lindl.		+	
Casuarina distyla, Vent.			+
Hakea rostrata, F. v. M.	+		
H. ulicina, R. Br.	+		
Banksia marginata, Cav.	+		
Stellaria palustris, Retz.		+	
Ranunculus lappaceus, Sm.	+	+	
Cassytha glabella, R. Br.	+		
Drosera pygmaea, DC.	+		
D. binata, Labill.		+	+
D. peltata, Sm.	+	+	+
D. auriculata, Backh		+	
D. Whittakeri, Planch.	+		
Acacia verticillata, Willd.	+	+	+
A. retinodes, Schlecht.		+	+
Sphaerolobium vimineum, Sm.		+	+
Viminaria denudata, Sm.	+	+	+
Dillwynia hispida, Lindl.	+		
Bossiaea prostrata, R. Br.	+		
Kennedya prostrata, R. Br.	+		
Oxalis corniculata, L.		+	
Hibbertia stricta, R. Br.	+		
H. acicularis, F. v. M.		+	
Hypericum japonicum, Thunb.		+	
Viola hederacea, Labill.		+	
Pimelea glauca, R. Br.	+		
Lythrum hyssopifolium, L	+	+	
Eucalyptus rubida, Deane & Maid.	+		
E. rostrata, Schlecht.	+	+	
Leptospermum scoparium, Forst.	+	+	+
L. lanigerum, Sm.			+
Melaleuca decussata, R. Br.		+	+
Halorrhagis teucrioides, A. Gray	+		
H. tetragyna, R. Br.	+		
H. micrantha, R. Br.		+	
Hydrocotyle callicarpa, Bunge.			+
Xanthosia pusilla, Bunge.		+	+
Epacris impressa, Labill.	+	+	+
Sprengelia incarnata, Sm.		+	+
Villarsia reniformis, R. Br.			
Gratiola peruviana, L.		+	
Euphrasia Brownii, F. v. M.	+	+	+
Utricularia lateriflora, R. Br.			+
U. dichotoma, Labill.		+	
Stylidium despectum, R. Br.	+		
Levenhookia dubia, Sond.			+
Leptorrhynchus squamatus, Less.	+	+	
Erechthites hispidula, DC.	+		
E. arguta, DC.		+	

It seems advisable to add a few notes on the above lists. The total number of species listed is 108, of which 53 occur in A, 59 in B, and 42 in C. Of the total species only 10, 9·2 per cent., are common to all three; this number is 18·8 per cent. of the flora of A, 16·9 per cent. of B, and 23·8 per cent. of C; 10 species occur in A and B but not in C; 13 species, 12 per cent. of the total, occur in B and C but not in A—this is 22 per cent. of B and 30·9 per cent. of C. These may be regarded as being a definitely peat-loving element of the flora. Only two species (*Centrolepis aristata* and *Microtis atrata*) occur in A and C but not in B, and it is probable that a more prolonged search would lead to the discovery of these in the other type.

A marked feature of the lists is the large number of species that are recorded from one only of the types; this number is more than half of total flora, 73 species, or 67·5 per cent. In A there are 30 peculiar species representing 56·6 per cent. of its flora, or 28·7 per cent. of the whole; while B has 26, 44 per cent. of its flora, or 24 per cent. of the whole. In C there are 17 species, the corresponding percentages being 56·6 per cent. and 15·7 per cent.

If allowance is made for these localized species the numerical relationships of the types become more obvious. Of the 35 species that occur in more than one type, 28·4 per cent. are common to all, 28·4 per cent. to A and B, and 37·4 per cent. to B and C. Only 5·7 per cent. occur in A and C but not in B. These figures clearly indicate the intermediate character of B.

The number of species in common to all three types is small, but it contains those plants, *e.g.*, *Cladium junceum*, *Patersonia longiscapa*, *Acacia verticillata*, *Viminaria denudata*, and *Leptospermum scoparium*, that give character to the more highly developed stages of the vegetation. Further, the lists are based on three particular examples only; there is no doubt that were a more extended area listed it would show a larger number of common species.

It is, perhaps, surprising that the type with the most marked habitat, C, the peat soil, should show the smallest flora and, still more, the smallest percentage of peculiar species. This is to a large extent due to the complete absence of invaders from dry land communities in this case. In the other lists some such plants are included, since they occur as normal constituents of the florulas.

8. Modifications.

Before consideration is given to the questions of relationships and successions among the communities, something must be said about the results of man's operations on the vegetation both as it exists and on regeneration. Under this general heading are included all such activities as felling, drainage, pasturage, and introduction of grazing animals and so on. Again, such things as fires, which have been considered already to some extent, would be included here. Other features to be taken into account are ringbarking of trees, which has in parts been carried on on a wholesale scale, and also the deliberate planting of trees. In any portion of the whole area here considered into which man has carried his activities in whatever form, a very noticeable and remarkable feature is the incoming of alien plants. Some of these, as has been noted, have spread beyond the direct range of modification and have come to occupy a definite place in the plant communities; others are more restricted. The introduction of grazing animals has had an especially marked effect on the vegetation, and when this is combined with fencing in of areas so that the action is more concentrated, in many cases the native flora has become almost eliminated, or even totally disappeared. The rapidity and completeness of this change from the indigenous flora to a community of alien species is very remarkable. In any consideration of these changes, and of the apparent ease with which the alien

invader overcomes the native flora, two things must be borne in mind: first, that the Australian flora has been geographically isolated from the rest of the world for a very long period of time; and secondly, that, till the arrival of the white man, there were no gregarious, close-grazing, herbivorous animals at all. The native plants consequently had not been in any way subjected to the selective operations of competition with newly arriving plants, or, more importantly, to close-grazing, even on the small scale carried out by a quite wild fauna. Consequently the introduction of cattle, sheep, horses, and rabbits, to mention only the most common, has had a much more profound effect than occurs in a country where such animals live naturally.

The long-continued geographical isolation, and the absence of any native browsing animals in a continent with a rather severe type of climate, appear to be important factors underlying this instability of the vegetation in the face of interference by man.

Where actual destruction of the native flora has occurred, its regeneration is handicapped to a greater or less extent by the small amount of seed that is produced. This lack of full seed-production is quite a notable feature of a large number of the plants. The aliens, on the other hand, are in nearly all cases very free-seeding plants. These alien plants are a very varied assemblage, both in their country of origin (Black, 1909) and in their growth forms; there are shrubs, undershrubs, and herbs, both annual and perennial. Some of them have been deliberate introductions that have spread beyond control, but the majority are of the nature of weeds; some are decidedly obnoxious weeds, that are disadvantageous from the practical standpoint. However, it is not proposed here to enter into any detailed account of these alien plants.

As might be expected, the more open "savannah" forests of blue gum, peppermint, or red gum have provided localities more readily captured by these aliens than the denser covering present in the stringybark forests. This is, however, to a considerable extent due to the soil types and to the relative ease of access. The stringybark forest occupies the least responsive type of soil and is also developed here on the plateau region which is the least accessible. Gullies, moist flats, and any moist situation, even in the stringybark forests, have been especially captured by aliens, and few exist in the more accessible parts of the ranges that have not been reached by some one or more of these invaders. Among the most widespread of these gully and moisture plants that have come in are *Rosa rubiginosa, Rubus fruticosus, R. diversifolius, Ulex europaeus, Cytisus canariensis, C. scoparius, Verbena bonnarensis, Rumex crispus, Verbascum virgatum,* and others.

Effect of Clearing Fires, etc., on Stringybark Forest.

The stringybark forests, which occupy the least valuable soils (in many cases soils which are wholly unproductive for agricultural processes), have suffered less direct interference than the other forest types. Felling for timber purposes has been carried on, and, on most of these ranges, really large trees are completely absent. *E. obliqua* sprouts readily from the stool and coppice woods are often formed when each stump produces many stems. When such coppice regeneration takes place and is not otherwise interfered with a very dense cover is produced that causes a suppression of many plants of the undergrowth. This dense canopy is, however, temporary. After a time only a limited number of the shoots survive and the forest assumes a condition very similar to the untouched one. On rocky soils before this dense cover is produced, *Themeda triandra* and *Lepidosperma semiteres,* with sometimes *Stipa scabra,* may become exceedingly abundant for a time after felling. The usual practice after

felling is to get rid of the *débris* by burning, which may, and often does, produce marked effects on the regeneration. The stools are often killed, so that coppice shoots do not form, and any regeneration has to come from seeds. These germinate very readily, and if the fire is not repeated, the forest commences to regenerate quite rapidly. The undergrowth in general passes through the phases described earlier, though the absence of cover and the disturbance that occurs to the soil and plants during the felling operations often allow entrance to a number of aliens, especially where cultivated ground or roadways are adjacent The most important aliens are *Cytisus canariensis*, and in sheltered places *Ulex europaeus*. These may spread with such rapidity that they capture the habitat completely, prevent regeneration of native plants, and drive out those existing. These plants, especially *Cytisus*, may spread in this way after a fire, even when felling has not taken place. *Rubus fruticosus* and *Rosa rubiginosa* also spread freely, but not to the exclusion of all others, as do *Cytisus* and *Ulex*. An exception is provided in the case of *Rubus fruticosus* (pl. xx., fig. 1), when growing beside a watercourse or swampy patch in the stringybark area. Besides the shrubby plants a number of smaller plants invade after interference and take a place among the native plants; examples of these are *Rumex acetosella*, *Cirsium lanceolatum*, *Plantago lanceolata*, and several annual grasses.

Grazing has not been carried out to a large extent in the stringybark forests owing to the lack of nutritive plants in their undergrowth. However, some of the forests at the lower levels have been grazed and changes produced thereby. Besides the prevention of tree regeneration and opening up of the ground cover by elimination of shrubs, partly by browsing and partly by trampling, a feature worthy of mention is the rapid and complete disappearance of *Themeda triandra*. This, the so-called kangaroo grass, is quite a useful fodder plant, but has very slight powers of regeneration after being eaten down. It is quite a common sight to find this grass tall and luxuriant on the outside of a grazing fence, while inside not a trace of it can be found.

Stringybark forests, in the absence of depasturing, rather rapidly recapture cleared ground when this is abandoned. The forests developing on such cleared areas soon assume the features of the surrounding untouched parts with certain exceptions; *Xanthorrhoea semiplana* when once eliminated seems almost unable to return, or, at any rate, does so at an exceedingly slow rate. One example may be quoted which occurred on the summit of a quartzite ridge. Here a portion of the forest had been cleared and used as an orchard. At the time of our visit this had been abandoned for twenty-four years. The once cultivated area was entirely covered with forest and was only distinguished from the surrounding untouched parts by the small size of the trees and a complete absence of *Xanthorrhoea*. *Epacris impressa* and *Pultenaea daphnoides* were present in rather less quantity. Very few aliens had survived, and none in any quantity.

Not inconsiderable portions of ground that was at one time occupied by stringybark forests have been cleared and planted with pines. *Pinus insignis*, and to a less extent *P. maritima*, have been used. Both these plants, and especially the latter, are spreading by seed to some extent into the forests. But in the absence of fires they do not seem able to defeat the natural vegetation. In some cases after a fire *P. maritima* is coming up in such quantity that with the amount of shade it casts it is ousting the natural forest. This, however, is rather local.

Changes in the Open Forest Types.

A different condition of things is seen in the case of the forests of blue gum and peppermint. Very few of these forests are without obvious traces of interference. The open canopy and the grass-like flora have from the time of

the earliest settlers been indicative of pasture land and have been used as such to a greater or less extent. This has caused in many cases an almost total removal of the native flora and its replacement by aliens which are either annuals or plants of tufted or rosette habit that withstand pasturage. Among the most common and widespread are *Briza maxima, B. minor, Aira caryophyllea, Dactylis glomerata, Plantago lanceolata, Erythraea centaurium, Anagallis arvensis, A. caerulea, Inula graveolens, Hypochoeris radicata, H. glabra,* with also *Medicago denticulata, Trifolium angustifolium,* and *T. tomentosum; Verbascum virgatum* has become almost dominant on some valley sides. Another plant that has become locally dominant and which is spreading rather rapidly is *Hypericum perforatum.* Where this plant is abundant it drives out all others. It resists fires and, as it is not touched by animals, if strong repressive measures are not taken it has all the appearance of becoming a very noxious weed and one which will cause a rapid deterioration of land.

Besides the herbaceous plants mentioned above some introduced shrubs are present in these forests. On dry rather rocky slopes *Gomphocarpus arborescens* and *Olea europaea* are abundant. *Lavendula Stoechas,* a comparatively recent incomer, is spreading very fast and has formed an almost closed cover in some parts. *Crataegus oxycantha* occurs in sheltered spots and, locally, *Lycium campanulaceum,* on the lowest slopes. Several others are occasional.

On the rolling "savannah" country on the east side of the hills much of the forest has been destroyed by ringbarking (pl. xvi., fig. 2, and pl. xix., fig. 1). This has occurred elsewhere, though not on a large scale, in these ranges. The process is carried on in order to obtain pasture land rapidly and cheaply. The killed trees are left standing. Ringbarking, followed by the introduction of stock in any quantity, completely prevents regeneration of the forest from seedlings and causes a considerable alteration in the ground flora owing to the introduction and spread of grasses and rosette plants. A quite short period of time with this treatment is sufficient to produce an apparently stable grassland community with no sign of trees. That this community is maintained by the grazing factor is demonstrable, however, by the fact that wherever the animals are excluded young trees make their appearance. For example, along railway lines and other enclosures young trees come up in numbers, though elsewhere there is no sign of them. In a few cases areas have been left untouched for some years and a vigorous forest has reappeared. Over most of the district studied, however, the forest is being destroyed faster than it can regenerate.

The peppermint forests, more than any other, have become altered by interference. Several factors have combined for this. The forest occupied the lowest and most accessible parts, consequently it was the first to be attacked. The soil holding water in winter is readily colonized by grass, and the trees, being small and of low timber value, have always been regarded as quite useless. The results have been that this type of forest has been enormously reduced in area, whilst, at the present day, only in the more remote and steeper portions has it retained anything approaching its natural flora. Much of the forest now has a flora composed wholly of alien plants which are largely grasses or grass-like. The commonest grasses are *Dactylis glomerata, Bromus maximus, B. mollis, B. unioloides, Festuca bromoides, Cynodon dactylon, Briza maxima, B. minor, Aira caryophyllea,* with many others. *Themeda triandra* appears only in places protected from grazing. Along with the grasses occur many other plants, of which only a few of the most abundant can be mentioned: *Inula graveolens, Cryptostemma calendulacea, Calendula arvensis, Hypochoeris radicata, H. glabra, Plantago lanceolata, Erythraea centaurium, Echium plantagineum, Bartsia latifolia, Trifolium angustifolium, Medicago denticulata, Oxalis cernua, Erodium*

moschatum, E. botrys, Romulea rosea, R. columnae, Sparaxis tricolor, and very many others. In a few portions where the forests have been left untouched for some time, *Acacia armata* has appeared in masses forming rather dense thickets.

The red gum forests have suffered in a similar way. Much of the land originally occupied has been used for cultivation and the forest destroyed altogether. But apart from this, the moist level situations have been chosen for pastures. Many of the aliens of the drier forests have appeared along with some that are much more abundant here, *e.g., Taraxacum officinale, Trifolium repens, Moenchia erecta, Juncus capitatus, J. bufonius.* Few of these woods are free of *Rosa rubiginosa,* which spreads very rapidly. *Rubus fruticosus, Crataegus oxyacantha,* and *Cytisus canariensis* have also locally spread in great quantities. Along the creeks themselves *Zantedeschia aethiopica, Watsonia Meriana,* and *Alisma plantago* have become established locally, along with others. *Rumex crispus* and *Foeniculum vulgare* are common on flats.

The red gum is especially active in the recapture of its habitats, however, where the disturbing factors are removed. Then thick groves of seedling trees appear, and in their early years grow with rapidity whether in a once pastured forest, a cleared area, or even on derelict arable land. Some interesting and instructive examples of this regeneration occur on these hills. One case may be noted here. The land 30-40 years ago was cultivated for wheat, but has since been abandoned, and at present is occupied by a dense forest of young red gums. The surface still bears a distinct impress of the furrow lines (pl xx., fig. 2). None of the other forests are able to regenerate so quickly and completely. In the case of blue gum the recolonization is rather slow, and on the slopes the young trees often appear in groups not infrequently associated with *Casuarina stricta.* Indeed, where blue gum and red gum habitats adjoin, the latter on recolonization appears to spread out and occupy part of the habitat of the former. Part, at any rate, of the spread of *E. rostrata* beyond the valley limits in the savannah country seems attributable to this much more vigorous seed regeneration. Exactly the same capture of marginal habitats occurs to some extent with stringybark, which can regenerate to a certain degree at the expense of the blue gum. These cases of capture of habitat require careful and detailed study and cannot be further considered at present.

When a habitat has become occupied by large numbers of alien shrubs, *e.g., Cytisus canariensis, Ulex europaeus, Rubus fruticosus,* etc., the regeneration of the light-demanding Eucalypts may be prevented altogether

9. Relationships and Development

The area of the Mount Lofty Ranges that has been studied covers regions of annual precipitation varying between 20 inches to over 40 inches. Eighty per cent. or more of this precipitation falls within the winter months. Thus the area includes several distinct climates, each of which, as we shall see, has its own characteristic development of vegetation.

As a whole, the area is at present a region of geological stability; the agents of erosion and change are not active, and as a result the habitats are more or less permanent and not changing. This stability is clearly indicated in the small amount of erosion that has taken place since the earth movements that raised up the very ancient rocks that make up these hills. Even in those cases when rivers have cut right across the main watershed ridge the valleys formed are deep and approaching their base level, and, with an almost complete absence of lateral drainage channels, are not enlarging to any extent. The most striking evidence of the geological stability, as pointed out by Howchin (1910), is afforded by the existence of the rather extensive glacial deposits of presumably Permocarboni-

ferous age. These deposits are, in part at least, not even consolidated as rock and are yet still extensive.

This habitat stability, combined with the geographic isolation of the continent, which has prevented plant migrations and invasions, has resulted in nearly all the vegetation having continued its development to the climax permitted by the climate and the local habitat conditions.

Stringybark Formation.

The most clearly defined vegetation unit is that of the stringybark forest which covers the quartzitic backbone of the ranges. This forms a homogenous group of communities with a distinct habitat and developed in a definite climatic zone of 30 inches or more of rainfall, the bulk falling in the Winter. The chief stable community here is evidently the *E. obliqua* forest. This is widespread and has all the features of a climax community. Is is relatively complex, exceedingly stable, and, if destroyed, has very marked powers of regeneration. The forest must be regarded as an association (Clements, p. 128) made up of two consociations, dominated by *E. obliqua* and *E. capitellata*, respectively. These two forests certainly appear to be the result of slight changes of habitat within the climatic zone. There is no evidence that the one can develop into the other. On the other hand, the positions of *E. fasciculosa* woods and *Casuarina* scrub are quite different. Both appear as developmental stages in the sere that culminates in the *E. obliqua-E. capitellata* forest climax. These stages are, however, often rendered apparently stable and fixed owing to local edaphic or physiographic conditions. *E. fasciculosa* occurs, as noted above, in situations which are liable to drought or when the soil is very shallow or rocky. Wherever the conditions are less extreme the climax forest appears. Good examples of this are very frequent; on narrow ridges the crest is often covered by *E. fasciculosa*, while the slopes have *E. obliqua*. Again, in Morialta Gorge, the main slopes are covered by *E. fasciculosa* woods, but where a southerly exposure occurs there *E. obliqua* appears. *E. fasciculosa* represents in these cases the furthest stage that the development can reach under the local conditions, but, wherever these are improved, the final stage can be reached. As was pointed out earlier the flora, as a whole, in a pink gum forest is that of the climax stringybark, though without those plants that demand more moisture, shelter, humus, etc. As further evidence of the fact that pink gum is a developmental stage, it may be again noted that this tree is frequently present in large quantity where regeneration after destruction is taking place.

Forests of pink gum were described as occupying the rocky outcrops from which the loose glacial deposits have been washed off. Here the exposure of the underlying rock is relatively recent (Howchin, 1910), and the forests existing may perhaps represent the furthest stage that the development has yet reached.

The community of *Casuarina stricta* and *Xanthorrhoea quadrangulata*, which occurs on the steep, very rocky slopes, is a still earlier stage existing when development is suspended until the soil is produced. Here, indeed, the further stages are indicated wherever conditions allow, *e.g.*, on talus slopes, in gullies, etc., where *E. fasciculosa*, or even *E. obliqua*, are found. Again, in many forests on steep valley sides individuals of this community often occur scattered through a forest, and may be regarded as relics of an earlier phase. It is not to be assumed, of course, that all these communities represent stages in the primary sere leading to the climax forest in the sense that all the forest has at one time passed through them. Rather is it considered that under the special edaphic conditions the development reaches these stages and, should the conditions become favourably modified, then the climax forest will come in.

Exactly the same arguments apply to the scrub of *Casuarina distyla* Here again, as was pointed out earlier, further development is indicated in the presence of groups or individuals of *E. fasciculosa* or *E. capitellata*.

The position of the *E. cosmophylla* scrub has already been considered to some extent. It appears to represent a stable end point determined by the edaphic factors. Looked at from the standpoint of general development this community, being a scrub forest, is less advanced than the high forest of *E. obliqua* which occurs in exactly the same climate. It is, perhaps, most logical to regard the *E. cosmophylla* scrub as a subclimax prevented from the normal development to high forest by edaphic conditions. The dwarf scrub of *E. capitellata* on the glacial deposits occupies a completely analagous position, and is again an edaphic subclimax. The relationship is clearer here, perhaps, because the climax forest appears in gullies and by streams in this region.

The relations of the forests of *E. elaeophora* to those of *E. obliqua* and *E. capitellata* have been discussed earlier. There seems little doubt that in this case we are dealing with a climax. It is one closely allied to the *E. obliqua-E. capitellata* climax, and one with very similar development. As suggested earlier, it appears to be differentiated by climatic and edaphic factors. Taking all the evidence into consideration, we can hardly escape the conclusion that all these communities belong to one formation—the stringybark formation The climax of this is an association of *E. obliqua* and *E. capitellata* on the one hand and a consociation of *E. elaephora* on the other. All the other communities are of subsidiary grade, and are either developmental phases or subclimaxes due to special edaphic conditions. In the gully flora of the Mount Lofty forests there is an indication of a type of stringybark forest developed in a moister climate.

Savannah Woodland Formation—a. Blue Gum Forest

When attention is turned to the blue gum forests a very marked contrast is at once apparent. They differ not only in habitat, but still more in the facies, structure, and flora. As mentioned, the transition is often abrupt, but further, these forests occupy a different though contiguous climatic zone. While the stringybark forest does not occur where the rainfall is much less than 30 inches, the blue gums flourish between 25-35 inches, and even occur where the rainfall is as low as 20 inches. Within this zone and on the suitable soils *E. leucoxylon* forms a climax forest. It is almost universally present here; it is a stable community, though reproduction is often slow. Developmental stages occur, though they are less apparent as the characteristic tree of the climax appears at an early stage. *E. viminalis*, which is so frequently an associate of *E. leucoxylon*, occurs where the conditions are rather moister, and more especially where the extremes of atmospheric dryness are less. It occurs especially in gullies. The pure forests of *E. viminalis* which occur locally, as described above, represent a consociation of moist conditions.

The communities of varying size of *Casuarina stricta* which occur on rocky outcrops occupy an interesting position in the developmental story. If one travels from the Mount Lofty Ranges eastwards towards the "Ninety-mile Desert" one crosses zones of progressively decreasing rainfall. The forest is found to become more and more open, and finally to disappear and be replaced by scrub communities, *e.g.*, mallee Eucalypts. The only woodlands that occur are those on rocky places composed of *Casuarina stricta*. Under rainfall conditions where rocky soils alone can support forest these *Casuarina* woods must be regarded as a climax. But when the conditions are more favourable, as in the Mount Lofty Ranges themselves, the development can continue beyond the stage of *Casuarina* woods, which only exists under special edaphic conditions. In the region under study this community must be regarded as an edaphic subclimax.

Now, although the climatic zones, which here produce blue gum forests and stringybark forests, respectively, are so close or even identical, it seems impossible to regard the two as belonging to one formation. The composition, structure, and development of the two climax forests are so totally distinct. Evidence of the essential difference of the two types becomes much more apparent when consideration is taken of the region adjacent to these ranges. On the hills further north and on the Flinders Ranges, which have a lesser rainfall, forests of blue gum or of other species, with the same general structure and flora, are present, but not the stringybark type. To the south and east, however, the latter type becomes the more prevalent. At Mount Gambier, for example, with a rainfall of 35-40 inches, forests of *E. obliqua* occur at sea level. Again, in the mountains of Victoria where, not only is the rainfall higher but less confined to Winter months, the forests approach much more closely to the stringybark type; *E. obliqua* forests are present. On the drier northern exposures of the Dandenong Range in Victoria, for instance, forests very much like those described do occur; elsewhere in the same district the type is more allied to the "gully flora" in the Mount Lofty area. The savannah type of forest is not present on these Victorian mountains.

At Mount Lofty it would thus appear that we are dealing with the ecotone between two forest types. The stringybarks are approaching their limit owing to dryness, while the more continental blue gum forests are nearing the moister end of their range. At the junction region edaphic factors become more apparent in differentiating the two which are broadly separated climatically. The *E. elaeophora* forest which, as has been shown, has some features in common with the blue gum forest, represents an extreme climatic variant of the stringybark formation.

Savannah Woodland Formation—b. Peppermint Forest.

The peppermint forests are allied to those of blue gum both in structure and in flora. These forests occur in regions of rather less rainfall, and on the whole with a soil difference. This soil difference is, however, rather slight, and in places one or other type of forests occurs on intermediate soils. On the foothills above the Adelaide plains *E. odorata* frequently clothes northern exposures, and *E. leucoxylon* southern ones, on the same soils and at the same altitude. As is the case with the forests discussed above, so here, the two are climatically determined though their zones overlap. In the neighbourhood of Kapunda, for example, and on the hills to the north of "the Kapunda gap," *E. leucoxylon* forests are confined to the main ranges, which have a rainfall of 22 inches and upwards, while on the drier foothills *E. odorata* occurs. *E. odorata* also extends on to the plains, and as a mallee may reach zones with a rainfall as low as 12 inches. While one must thus regard both the *E. odorata* forests and those of *E. leucoxylon* as representing the climax types of distinct but similar climates, yet the resemblances and similarities in structure, flora, and behaviour are so marked that it does not seem advisable to treat them as belonging to separate formations. They belong to the same climatic type, with rather low rainfall, mainly occurring in Winter, but to different zones of it. At present we consider them as representing two subformations of what for the moment may be termed the savannah woodland formation.

Red Gum Forest.

The red gum forests are quite distinct. They form a unit determined by the edaphic factor of abundant ground water, at any rate for a season. It is essentially a river and creek-side formation, and as such occurs over a very wide

range and in several different climates. This forest is the most widespread of any type in Australia, occurring, as it does, wherever the necessary habitat conditions are present and the rainfall is 8 inches or more. In regions of lesser rainfall *E. microtheca* takes the place of *E. rostrata*. To the east of the Dividing Range in New South Wales the forests in these situations are composed of the closely allied *E. tereticornis*.

In the region under consideration the red gum forests are only small outliers. In structure they are much more closely allied to the savannah forest than to the stringybark. This alliance is further evidenced in the broad zone of mixed forest that often occurs between red gum and blue gum.

Swamps.

The swamps must be treated as a separate group at present with a community of *Leptospermum scoparium* representing the highest phase of their development. In the entire absence at present of any evidence for or against the stability of this community, it is unwise to state what rank this is or what its relations to the climatic climaxes may be.

VII. SUMMARY.

Three formations are recognized on the Mount Lofty Ranges, namely:—

I. STRINGYBARK FORMATION with a Winter rainfall of 30 inches or more. This is made up of an association of *E. obliqua* and *E. capitellata*, the former often, and the latter occasionally, as a pure consociation. There is also consociation of *E. elaeophora*. In addition, there are edaphic subclimaxes of *E. cosmophylla* scrub and of dwarf *E. capitellata* scrub. Various scrub communities occur

II. SAVANNAH WOODLAND FORMATION, with a rainfall of 15-35 inches, with two subformations:—*(a)* Blue gum subformation; *(b)* peppermint subformation, representing the wetter and drier zones.

III. RED GUM FORMATION, a river-side forest on deep soils holding water.

Lastly, there are swamps whose exact relations are not determined.

Turning to the general relationships of these formations, rather varied opinions have been expressed as to the type to which the forests belong. They have been described both as sclerophyll forests and as savannah forests (Diels, Taylor, Osborn, 1914). On this point the dominant tree alone gives very little indication. The genus *Eucalyptus*, with its very numerous species, has a xerophytic leaf that approaches often very closely the so-called typical sclerophyll, but this type of leaf, in Australia, is possessed by trees occurring in such a variety of climate and habitat that it has no indicator value. It occurs here where the climate is essentially the sclerophyll type, also in the much more arid regions of the mallee country on the plains by the River Murray. Again, in the rain forests of Victoria, and even of Tasmania, with a wholly different climate, the same leaf type occurs on the trees (Rodway). Indeed, the leaf form of *Eucalyptus* cannot be regarded as being directly correlated with its present habitat; it seems rather a hereditary ancestral feature which is only capable of very slight modification under existing conditions. These remarks apply not only to *Eucalyptus*, but to other genera as well, notably to the phyllode-bearing species of *Acacia*.

Consequently to arrive at a conclusion as to the type to which a community belongs it is necessary to take the whole flora into account. Here, as mentioned earlier, one is struck by the great variety of leaf form and growth habit in the stringybark forest. While the whole flora is xerophytic it covers a wide range of detail. The stringybark forests, however, agree in most features with other regions of sclerophyll woodland. The much greater forest development is

striking as compared, for example, with the Cape Peninsula or Corsica. As compared with the Mediterranean generally the flora here is distinctly more xerophytic and has many fewer flat-leaved species. It also shows much less of the transitions to a "laurel" type in gullies, etc.

While the stringybark forest can be treated as a true sclerophyllous forest, the savannah forest belongs to a quite distinct type. Both from their distribution and structure these forests belong to a drier type and more continental climate The sclerophyll is essentially an oceanic or suboceanic type, and here we have it in its most continental form The savannah forest, which becomes dried up and dormant to a very large extent in Summer, is a stage further from the oceanic types. It is interesting that the forests of *E. elaeophora*, standing as they do at the climatic limit of the stringybark (sclerophyll) formation, do show certain features of approach to the savannah forest This is especially the case in those in which *Lepidosperma* spp. becomes more or less dominant on the ground. The savannah forests here show most relation perhaps to some of the woodlands of Argentina (Schimper, p. 457).

VIII. APPENDIX A. LIST OF SPECIES AND STATISTICS.

The following list of species contains all those plants, found by us during the course of our investigations, that is between July and December, 1922 No attempt is made to give a complete list of the known flora No plant is recorded in the list of which we ourselves have not collected a specimen.

The nomenclature adopted is that used in J M. Black's "Flora of South Australia" so far as issued; otherwise we have followed Bentham's "Flora Australiensis" and Tate's "Handbook" The more recent changes necessary in nomenclature owing to the International Rules have been adopted with reference to the names used by Maiden and Betche in their "Census of New South Wales Plants." The sequence of species is based on Engler's system, which is that adopted by Black and by Maiden and Betche.

The identifications have been checked by reference to specimens in the Tate Herbarium in the University of Adelaide. A number of doubtful or critical plants have, further, been seen, and our identifications checked, by Mr. J. M. Black, to whom we would like to take this opportunity of expressing our very sincere thanks.

In the first column in the list are given the symbols in common use for the life-form class as defined by Raunkiaer. The allocation of some of the species to their class presented a certain amount of difficulty owing to lack of a full knowledge of the behaviour of the plants; the published descriptions in the floras are frequently lacking in exact details in this connection, and a considerable amount of further work is necessary on this subject before a really accurate "Spectrum" can be obtained. The present list with the life-form classification, though it certainly contains inaccuracies, is sufficiently complete for a limited ecological region to allow of a few preliminary generalizations. Though these are all necessarily somewhat tentative, we feel justified in giving them, as so little work of this kind has so far been done in Australia. We hope that this attempt may stimulate others to follow, and to carry the work further and to more exact conclusions than we have been able to reach.

The results obtained by us for this flora, when compared with those we have already published (Adamson and Osborn) for the much more arid district of Ooldea, suggest that this method may be of considerable value in a discrimination of the different climatic zones in a continent like Australia.

1. Biological Spectra.

In the list 362 native plants are enumerated. In the accompanying table the "Biological Spectrum" is given along with the "Normal" and those of some other districts for comparison:—

	Total	MM.	M	N	Ch.	H.	G	T.	HH	E.	S.
Mount Lofty	.. 362	2	8	25	12	24	17	10	1	(1)1·5	—
Normal*	. 400	6	17	20	9	27	3	13	1	3	1
Madeira (Lowld.)*	213		1	14	. 7	24	—	51	3	—	—
Ooldea†	. 188	0·5	19	23	14	4	0·5	35	.	(1)4	—
Denmark*	1084	1	3	3	3	50	11	18	11	0·1	—
Long Is., U.S.A.‡	719	5	6·5	3	6	33	20	14	11	-	—

*Smith. †Adamson and Osborn. ‡Taylor.

Comparing this spectrum with the normal, the most marked features are the high figures for Geophytes and for the small woody plants, Nanophanerophytes and Chamaephytes; these last together make 37, as compared with 29 in the normal.

The spectrum shows clearly the climatic influences when a comparison is made with other floras. The high percentages of Micro- and Nanophanerophytes and moderate Chamaephytes are indicative of dry warm conditions as contrasted with the high figures for Hemicryptophytes in the cool temperate climates of Denmark and Long Island (Smith, Fuller and Bakke) The possession of a seasonal rainfall is shown by the large numbers of geophytes and not inconsiderable numbers of Hemicryptophytes. The high figure for geophytes is an indicator of the Winter rains, and forms a contrast with the figures for Summer rain regions which have an excess of Hemicryptophytes or of Therophytes.

The relatively low percentage of annuals here further indicates a regular precipitation, as contrasted with the high figures in the floras of regions with irregular rains, as Ooldea or Madeira.

It would be interesting to compare the spectrum of the Mount Lofty area with that of one of the other sclerophyll regions of the world, but none is available at present.

A comparison of the "spectra" of the floras of the two main formations here is of interest and brings out in a striking manner the essential differences between them.

These spectra are made up from the lists; that for stringybark forests includes the lists given for stringybark, box, and the dwarf scrub; the savannah forest list is for blue gum forests and peppermint forests. The following table gives the results:—

	Total	MM.	M.	N.	Ch	H	G.	T	HH.	E.
Stringybark	.. 244	1	9	34	13	23	13	4	0·1	(1)1
Savannah	.. 229	1	8	14	12	26	23	14	—	(1)1·5
Normal	. .. 400	6	17	20	9	27	3	13	1	3

The differences are both striking and important. The stringybark shows a decided excess of Nanophanerophytes and an abnormally small percentage of Therophytes, while the savannah has a rather small number of the former but a large percentage of Geophytes and the normal percentage of Therophytes. The differences in the figures for these groups mark a different type of flora, and add a further reason for the separation of the two formations. The large proportion of Geophytes and Therophytes in the savannah suggest the flora characteristic of a climate with a less regular precipitation than the nanophanerophytic flora of the stringybark forest. This is exactly the conclusion that was reached from a consideration of the geographical and other evidence considered earlier in this account.

(1) These percentages refer to species of *Loranthus*. True epiphytes are not found in these districts.

The spectrum of the savannah forest in many of its features is intermediate between that of the Ooldea flora on the one hand, and that of the stringybark forest on the other. This is additional support for the contention that the savannah forest is a formation of a more Continental type of climate than the stringybark forest. A consideration of its spectrum leaves no doubt at all that this formation is in no way a sclerophyll formation. The stringybark forest, on the other hand, has in its spectrum all the features of that type of vegetation.

2. Tabular List of Species.

In regard to the other portions of the list, the distribution of the species is given under six heads, namely:—Stringybark Forest, which includes *E. cosmophylla* Scrub and the "Maquis" Scrub; Box (*E. elaeophora*) Forest; the Dwarf Scrub of *E. capitellata*, as seen at Mount Compass; Blue Gum Forests, which include the savannah type of woodland, and also white gum and manna gum woodlands; Peppermint Forests; and, finally, Red Gum Forests.

Occurrence only is given, not the relative frequency in each type.

	Life Form	Stringy-bark	Box	Scrub (Mt. Cmps.)	Blue Gum	Pepper-mint	Red Gum
Adiantum aethiopicum, L.	H	x			x		
Cheilanthes tenuifolia, Sw	H.	x	x		x	x	x
Pteridium aquilinum, Kuhn.	G.	x	x		x	x	x
Blechnum discolor, Keys.	H.	x					x
B. capense, Schlecht.	H.	x					
Asplenium flabellifolium, Cav.	H.	x					
Gymnogramme leptophylla, Desv. . ..	H.	x			x		
Pleurosorus rutifolius, Fée	H.	x					
Todea barbara, T. Moore	Ch.	x					
Ophioglossum coriacium, A. Cunn. . ..	G				x		
Phylloglossum Drummondii, Kunze . .	G.					x	x
Isoetes Drummondii, A. Br. . ..	G.					x	x
Callitris cupressiformis, Vent.	M.				x	x	
Typha angustifolia, L.	HH.	x					x
Triglochin centrocarpa, Hook.	T.				x	x	x
T. procera, R. Br.	HH.						x
Themeda triandra, Forsk.	Ch.	x	x		x	x	x
Neurachne alopecuroides, R. Br.	H.	x	x	x	x	x	
Amphipogon strictus, R. Br.	H.	x		x			
Stipa setacea, R. Br.	H.	x	x		x	x	
S. eremophila, Reader	H.				x	x	
S. pubescens, R. Br.	H.	x	x		x	x	x
S. semibarbata, R. Br.	H.				x	x	
S. scabra, Lindl.	H.				x		
Sporobolus indicus, R. Br.	H.	x			x	x	
Calamagrostis quadriseta, Spreng.	H.					x	x
Dichelachne crinita, Hook. f.	H.	x					
D. sciurea, Hook. f.	H.	x	x		x		
Danthonia carphoides, F. v. M.	H.				x	x	
D. penicillata, F. v. M.	H.	x	x	x	x	x	x
Phragmites communis, Trin.	HH.						x
Poa caespitosa, Forst.	H.	x	x		x		
Agropyrum scabrum, Beauv.	H.				x		
Cyperus tenellus, L. f.	T.	x			x	x	x
C. vaginatus, R. Br.	H.	x			x		x
C. rotundus, L.	G.					x	
C. Gunnii, Hook. f.	G.				x	x	
Schoenus apogon, R. and S.	H.	x	x	x	x	x	x
Scirpus setaceus, L.	T.					x	x
S. nodosus, Rottb.	G.	x			x		x
Cladium junceum, R. Br.	G.			x		x	x
C. glomeratum, R. Br.	H.			x			
C. acutum, Poir.	H.			x			
Gahnia trifida, Labill.	Ch.	x					x

	Life Form.	Stringy-bark	Box.	Scrub (Mt. Cmps.)	Blue Gum	Pepper-mint.	Red Gum.
G. lanigera, Benth.	H.			x			
G. psittacorum, Labill.	Ch.	x					
Lepidosperma concavum, R. Br.	Ch.	x					
L. laterale, R. Br.	Ch.	x					
L. viscidum, R. Br.	Ch.	x			x		
L. semiteres, F. v. M.	Ch.	x	x	x	x		x
L. carphoides, F. v. M.	Ch.	x	x		x		
Carex appressa, R. Br.	Ch.	x			x		x
C. tereticaulis, F. v. M.	Ch.	x					x
C. Gaudichaudiana, Kunth.	H.				x	x	x
C. breviculmis, R. Br.	H.				x		
C. Gunniana, Boott.	H.	x					
Leptocarpus tenax, R. Br.	H.			x			
L. Brownii, Hook. f.	H			x			
Hypolaena lateriflora, Benth.	H.			x			
H. fastigiata, R. Br.	H.	x		x			
Lepidobolus drapetocoleus, F. v. M.	H.			x			
Brizula pumilio, Hieron.	T.				x	x	x
Centrolepis aristata, R. and S.	T	x	x		x	x	x
C. strigosa, R. and S.	T	x			x	x	x
Juncus planifolius, R. Br.	H.	x			x		x
J. caespiticus, E. Mey.	H						x
J. holoschoenus, Buch.	G.	x			x	x	x
J. lamprocarpus, Ehrh.	G				x	x	x
J. pallidus, R. Br.	H	x	x	x	x	x	x
J. polyanthemus, Buch.	H.						x
J. pauciflorus, R. Br.	H.	x			x	x	x
Luzula campestris, DC.	H.				x	x	
Dianella laevis, R. Br.	G.	x			x	x	
D. revoluta, R. Br.	G.	x	x	x	x	x	
Burchardia umbellata, R. Br.	G.				x	x	x
Anguillaria dioica, R. Br.	G.	x	x	x	x	x	x
Lomandra dura, Ewart	Ch.	x	x		x	x	
L. longifolia, Labill.	Ch.	x			x		
L. multiflora, J. Britten	Ch.	x					
L. effusa, Ewart	Ch.				x		
L. micrantha, Ewart	Ch.	x	x	x	x		
L. filiformis, J. Britten	Ch	x					
Thysanotus Patersonii, R. Br.	G.	x			x	x	x
Caesia vittata, R. Br.	G.				x	x	
Chamaescilla corymbosa, F. v M.	G.	x	x		x	x	x
Tricoryne elatior, R. Br.	G.	x	x		x	x	x
Bulbine bulbosa, Haw.	G.	x			x	x	x
Arthropodium paniculatum, R. Br.	G.	x			x		x
Dichopogon strictus, J. G. Bak.	G.	x	x	x	x	x	x
Bartlingia sessiliflora, F. v. M.	H.					x	x
Xanthorrhoea quadrangulata, F. v. M.	M.	x					
X. semiplana, F. v. M.	Ch.	x	x	x	x		
Hypoxis glabella, R. Br.	G.	x			x	x	x
H. pusilla, Hook. f.	G.				x	x	
Patersonia longiscapa, Sweet	H.	x					x
Dipodium punctatum, R. Br.	G.	x					
Thelymitra ixioides, Sw.	G.				x	x	
T. azurea, Rogers	G.			x			
T. grandiflora, Fitzg.	G.	x					
T. aristata, Lindl.	G.				x	x	
Microtis porrifolia, Spreng.	G.			x		x	
Prasophyllum elatum, R. Br.	G.	x					
P. fuscum, R. Br.	G.				x		
P. nigricans, R. Br.	G.				x	x	
Corysanthes fimbriata, R. Br.	G.				x	x	
C. pruinosa, R. Cunn.	G.	•			x		
Acianthus caudatus, R. Br.	G.	x			x	x	
A. exsertus, R. Br.	G.	x					
Lyperanthus nigricans, R. Br.	G.	x					
Eriochilus autumnalis, R. Br.	G.	x					

	Life Form.	Stringy-bark.	Box.	Scrub (Mt. Cmps)	Blue Gum	Pepper-mint.	Red Gum
Leptoceras fimbriata, Lindl.	G.	x					
Caladenia Patersonii, R. Br.	G.				x	x	
C. dilatata, R. Br.	G.					x	
C. carnea, R. Br.	G.	x	x	x	x	x	x
C. deformis, R. Br.	G.				x	x	x
Glossodia major, R. Br.	G.	x			x		
Diuris pedunculata, R. Br.	G.				x		
D. palustris, Lindl.	G.				x	x	x
D. maculata, Sm.	G.				x		
D. longifolia, R. Br.	G.				x	x	x
D. palachila, Rogers	G.				x	x	
Pterostylis nutans, R. Br.	G.				x		
P. nana, R. Br.	G.	x			x	x	
P. pedunculata, R. Br.	G.				x		
P. cucullata, R. Br.	G.	x			x	x	
P. reflexa, R. Br.	G.				x		
P. vittata, Lindl.	G.				x		
Casuarina stricta, Ait.	M.	x	x		x	x	
C. distyla, Vent.	M.	x	x	x	x		
Parietaria debilis, G. Forst.	T.					x	
Isopogon ceratophyllus, R. Br.	N.	x	x	x	x		
Adenanthos terminalis, R. Br.	N.			x			
Conospermum patens, Schlecht.	N.			x			
Persoonia juniperina, Labill.	N.	x	x	x			
Grevillea lavendulacea, Schlecht.	N.	x	x	x			
Hakea vittata, R. Br.	N.				x		
H. rostrata, F. v. M.	M.	x	x	x	x		
H. rugosa, R. Br.	N.				x	x	
H. ulicina, R. Br.	M.	x	x	x			
Banksia marginata, Cav.	M.	x	x	x	x		x
B. ornata, F. v. M.	N.	x		x			
Exocarpus cupressiformis, Labill.	M.	x	x		x		
Fusanus acuminatus, R. Br.	M.					x	
Choretrum glomeratum, R. Br.	N.			x			
Loranthus exocarpi, Behr.	E.	x			x	x	
L. Miquellii, Lehm.	E.	x			x	x	x
Trichinium erubescens, Moq.	T.				x	x	
T. alopecuroideum, Lindl.	T.					x	
Stellaria palustris, Retz.	H.	x					x
S. flaccida, Hook.	H.	x					x
Sagina apetala, L.	T.				x	x	x
Clematis microphylla, DC.	H.					x	
Ranunculus lappaceus, Sm.	H.	x	x		x	x	x
R. rivularis, Banks and Soland	H.	x					x
Cassytha glabella, R. Br.	E.	x	x	x			
C. melantha, R. Br.	E.	x	x	x	x	x	x
C. pubescens, R. Br.	E.				x	x	
Nasturtium palustre, DC.	H.					x	x
Cardamine hirsuta, L.	H.					x	
C. laciniata, F. v. M.	H.	x					
Drosera granduligera, Lehm.	T.						x
D. Whittakeri, Planch.	G.	x	x	x	x	x	x
D. pygmaea, DC.	T.					x	x
D. Menziesii, R. Br.	G.	x	x	x			
D. auriculata, Backh.	G.	x	x		x	x	x
D. peltata, Sm.	G.	x			x	x	x
Tillaea verticillaris, DC.	T.					x	
T. macrantha, Hook.	T.	x					
Pittosporum phillyraeoides, DC.	M.					x	
Bursaria spinosa, Cav.	M.	x			x	x	x
Marianthus bignoniaceus, F. v. M.	N.	x		x			
Billardiera cymosa, F. v. M.	N.	x		x			
Cheiranthera linearis, A. Cunn.	N.	x					
Rubus parvifolius, L.	N.	x					x
Acaena ovina, Cunn.	H.	x	x		x	x	x
A. sanguisorbae, Vahl.	H.	x					

	Life Form.	Stringy-bark.	Box.	Scrub (Mt. Cmps.)	Blue Gum	Pepper-mint.	Red Gum
Acacia spinescens, Benth.	M.	x			x	x	
A. rupicola, F. v. M.	M.	x					
A. armata, R. Br.	M.	x			x	x	x
A. obliqua, Cunn.	M.				x	x	
A. retinodes, Schlecht.	M.	x			x		x
A. pycnantha, Benth.	M.	x			x	x	x
A. myrtifolia, Willd.	M.	x	x	x			
A. verniciflua, Cunn.	M.	x					
A. melanoxylon, R. Br.	M.	x			x	x	x
A. verticillata, Willd.	M.	x		x			x
Gompholobium minus, Sm.	N.	x	x	x			
Sphaerolobium vimineum, Sm.	N.			x			
Viminaria denudata, Sm.	M.			x			x
Daviesia corymbosa, Sm.	N.	x					
D. ulicina, Sm.	N.	x	x		x	x	
D. brevifolia, Lindl.	N.	x	x	x	x	x	
Pultenaea daphnoides, Wendl.	N.	x					
P. acerosa, R. Br.	N.	x					
P. largiflorens, F. v. M.	N.	x		x			
P. pedunculata, Hook.	N.			x			
P. graveolens, Tate	N.	x		x	x		
P. villifera, Sieber	N.			x			
P. villosa, Willd.	N.	x		x			
Eutaxia empetrifolia, Schlecht.	N.				x		
Dillwynia hispida, Lindl.	N	x	x	x	x	x	x
D. ericifolia, Sm.	N.			x			
D. floribunda, Sm.	N.			x			
Platylobium obtusangulum, Hook.	N.	x	x	x	x		
Bossiaea prostrata, R. Br.	N.	x			x	x	x
Lotus australis, Andr.	H.				x	x	x
Indigofera australis, Willd.	N.				x	x	
Swainsonia lessertiifolia, DC.	H.				x		
Glycine clandestina, Wendl.	H.	x	x		x	x	
Kennedya prostrata, R. Br.	N.	x	x	x	x	x	x
Hardenbergia monophylla, Benth.	N.	x					
Geranium pilosum, Forst.	H.	x	x		x	x	x
Erodium cygnorum, Nees	T.					x	
Oxalis corniculata, L.	G.	x	x		x	x	x
Linum marginale, Cunn.	H.				x	x	
Correa speciosa, Andrews	N.	x	x	x			
Zieria veronicea, F. v. M.	N.			x			
Boronia caerulescens, F. v. M.	N.	x		x			
Geijera parviflora, Lindl.	N.			x			
Tetratheca ericifolia, Sm.	N.	x	x	x	x	x	
Comesperma volubile, Labill.	N.			x			
C. calymega, Labill.	H.				x	x	
Phyllanthus thymoides, Sieb.	N.			x			
Euphorbia Drummondii, Boiss.	T.					x	
Poranthera ericoides, Klotsch.	N.			x			
P. microphylla, Brongn.	T.	x		x	x	x	
Amperea spartioides, Brongn.	N			x			
Stackhousia linarifolia, A. Cunn.	Ch.	x	x	x	x	x	x
Dodonaea viscosa, Jacq.	N.	x			x	x	x
Spyridium parvifolium, F. v. M.	N	x					
S. subochreatum, Reiss.	N.	x					
S. spathulatum, F. v. M.	N.	x		x			
S. coactilifolium, Reiss.	N.	x		x			
S. vexilliferum, Reiss.	N.	x	x	x			
Cryptandra hispidula, Reiss.	N.	x			x	x	
C. propinqua, A. Cunn.	N.			x			
Thomasia petalocalyx, F. v. M.	N.				x	x	
Hibbertia sericea, Benth.	N.	x	x	x	x	x	x
H. stricta, R. Br.	N.	x	x		x	x	x
H. acicularis, F. v. M.	N.	x	x	x	x	x	x
H. virgata, R. Br.	N.				x		
Hypericum japonicum, Thunb.	H.	x			x	x	x

	Life Form.	Stringy-bark.	Box.	Scrub (Mt. Cmps.)	Blue Gum.	Pepper-mint.	Red Gum.
Viola hederacea, Labill.	H.	x		x	x		x
V. betonicifolia, Sm.	H.						x
Hybanthus floribundus, F. v. M.	N.	x	x	x			
Pimelea phylicoides, Meissn.	N.	x		x			
P. octophylla, R. Br.	N.	x		x			
P. glauca, R. Br.	N.	x	x	x	x	x	x
P. stricta, Meissn.	N.			x			
P. humilis, R. Br.	N.				x	x	
P. flava, R. Br.	N.			x			
P. Husseyeana, Tate	N.			x			
Lythrum hyssopifolium, L.	H.					x	x
Eucalyptus obliqua, L'Herit.	MM.	x					
E. capitellata, Sm.	MM.	x		x			
E. leucoxylon, F. v. M.	MM.				x		
E. odorata, Behr.	M.					x	
E. rubida, Deane and Maid.	MM.	x			x		x
E. elaeophora, F. v. M.	M.		x				
E. viminalis, Labill.	MM.	x			x	x	x
E. rostrata, Schlecht.	MM.				x		x
E. cosmophylla, F. v. M.	M.	x		x			
E. fasciculosa, F. v. M.	M.	x	x	x			
Leptospermum scoparium, Forst.	N.	x	x	x	x	x	x
L. lanigerum, Sm.	M.	x			x		x
L. myrsinoides, Schlecht.	N.	x	x	x	x	x	x
Callistemon salignus, DC.	M.						x
Melaleuca decussata, R. Br.	N			x			
M. parviflora, Lindl.	M.				—	x	
Baekea diffusa, Sieb.	N.			x			
Calythrix tetragona, Labill.	N.	x	x	x	x	x	x
Epilobium glabellum, Forst.	H.	x			x	x	x
Halorrhagis tetragyna, Hook. f.	H.	x			x	x	x
H. teucrioides, DC.	H.				x	x	
H. ceratophylla, Zahlb.	H	x			x	x	
H. heterophylla, Brongn.	H.				x	x	
Hydrocotyle laxiflora, DC.	H.	x					
H. hirta, R. Br.	H.				x		
H. callicarpa, Bunge	C.	x			x	x	x
Xanthosia pusilla, Bunge	H.			x			
X dissecta, Hook.	H.			x			
Eryngium rostratum, Cav.	G.				x	x	
Daucus brachiatus, Sieb.	T.	x		x	x	x	x
Astroloma humifusa, Pers.	N.	x	x	x	x	x	x
A Sonderi, F. v. M.	N.	x	x	x	x	x	
Lissanthe strigosa, Sm.	N.	x			x		
Leucopogon virgatum, R. Br.	N.	x	x	x	x	x	x
L. concurvum, F. v. M.	N.			x			
L. cordifolium, Lindl.	N.	x					
L. hirtellum, F. v. M.	N.	x					
Acrotriche serrulata, R. Br.	N.	x	x	x	x	x	x
A. fasciculiflora, Benth.	N.	x					
Epacris impressa, Labill.	N.	x		x	x		x
Samolus repens, Pers.	Ch.				x	x	x
Logania linifolia, Schlecht.	N.	x		x			
L. longifolia, R. Br.	N.	x					
Sebaea ovata, R. Br.	T.				x	x	
Erythraea spicata, F. v. M.	H.				x	x	x
Villarsia reniformis, R. Br.	HH.						x
Convolvulus erubescens, Sims	T.				x	x	
Wilsonia rotundifolia, Hook.	H.	x					
Halgania cyanea, Lindl.	N				x		
Prunella vulgaris, L.	H				x	x	x
Ajuga australis, R. Br.	H.				x	x	
Anthocercis angustifolia, F. v. M.	N.	x					
Gratiola peruviana, L.	H.	x			x	x	x
Veronica Derwentia, Andrews	N.	x					x
Euphrasia Brownii, F. v. M.	H.	x	x	x			

	Life Form	Stringy bark	Box	Scrub (Mt Cmps)	Blue Gum	Peppermint	Red Gum
Polypompholyx tenella, Lehm	T					x	
Plantago varia, R Br	T					x	
Opercularia varia, Hook f	Ch	x			x	x	
O scabra Schlecht	Ch	x					
Asperula oligantha F v M	H				x	x	x
Galium umbrosum, Soland	H	x	x		x	x	x
G australe DC	T				x	x	x
Wahlenbergia gracilis, DC	T	x	x	x	x	x	x
Velleya paradoxa R Br	H				x		
Goodenia amplexans, F v M	N	x					x
G ovata Sm	N	x	x	x			x
G albiflora Schlecht	Ch				x		
G geniculata, R Br	Ch	x			x	x	
G pinnatifida Schlecht	H				x	x	
Scaevola microcarpa Cav	Ch	x	x		x	x	x
Dampiera rosmarinifolia, Schlecht	Ch	x					
Brunonia australis, Sm	H	x	x		x	x	
Stylidium graminifolium Swartz	Ch	x		x			
S calcaratum R Br	T					x	
S despectum, R Br	T				x	x	x
Olearia grandiflora Hook	Ch	x					
O tubuliflora Benth	N	x	x		x	x	
O Huegelii Benth	N	x					
Vittadinia australis A Rich	Ch				x	x	
Minuria leptophylla, DC	Ch				x		
Lagenophora Billardieri Cass	H				x	x	
Brachycome trachycarpa, F v M	Ch				x	x	
B diversifolia Fisch and Mey	Ch				x	x	
Siegesbeckia orientalis L	T	x					x
Flaveria australasica Hook f	T				x	x	x
Cotula coronopifolia L	T						x
C australis Hook f	T				x	x	
Isoetopsis graminifolia, Turcz	T					x	
Calocephalus Brownii F v M	Ch				x	x	
Craspedia Richea Cass	H	x	x		x	x	x
Rutidosis pumilo, Benth	T					x	x
Leptorrhynchus squamatus Less	Ch	x	x	x	x	x	x
Helichrysum Baxteri A Cunn	Ch	x		x	x		
H scorpioides Labill	Ch	x		x	x		
H lucidum, Henck	Ch	x					
H Blandowskianum Steetz	Ch	x		x			
H apiculatum, DC	Ch	x	x	x	x	x	x
H semipapposum DC	Ch	x		x			
Helipterum exiguum F v M	T					x	
Gnaphalium japonicum, Thunb	H	x			x	x	
Ixodia achilleoides R Br	N	x	x	x	x		
Erechthites arguta, DC	T			x			
E quadridentata, DC	H				x	x	
E hispidula, DC	H	x	x	x	x	x	
Senecio lautus, Soland	Ch	x			x	x	
S hypoleucus, Benth	N	x			x		
S brachyglossus, F v M	T					x	
Cymbonotus Lawsonianus Gaud	Ch				x	x	x
Microseris Forsteri, Hook f	G	x			x	x	x

IX—APPENDIX B LIST OF INTRODUCED PLANTS

The following list gives the commoner introduced plants which occur as constituents of the flora of the forest communities Weeds of roadsides and of cultivated land that do not enter the woods, and planted ornamental species, are not included

The list makes no attempt at completion, but gives only those plants of more general occurrence

The distribution is noted in five columns; four of these are the main forest types:—A, Stringybark; B, Blue Gum; C, Peppermint; D, Red Gum. The fifth column, E, contains those plants which are confined to creek-sides or to very wet spots. Where occurrence is confined to this column a general distribution in wet places is meant:—

List of Commoner Introduced Plants.

	A.	B.	C.	D.	E.
Pinus halepensis, Mill.			x		
P. maritima, Poir.	x	x			
P. insignis, Dougl.	x				
Aponogeton distachyus, Thunb.	x				x
Alisma plantago, L.	x				x
Phalaris minor, Retz.		x	x	x	
Anthoxanthum odoratum, L	x	x	x	x	
Phleum pratense, L.			x	x	
Alopecurus agrestis, L.		x	x		
Agrostis verticillata, Vill.				x	
Arundo donax, L.	x			x	x
Lagurus ovatus, L.	x	x	x	x	
Holcus lanatus, L.		x	x	x	
Dactylis glomerata, L.	x	x	x	x	
Aira caryophyllea, L.	x	x	x	x	
Briza minor, L.	x	x	x	x	
B. maxima, L.	x	x	x	x	
Koeleria cristata, Pers.		x	x		
Avena fatua, L.			x		
A. sativa, L.			x		
Festuca myuros, L.		x	x		
F. bromoides, Sm.	x	x	x		
F. rigida, Kunth.			x		
Bromus maximus, Desf.	x	x	x	x	
B. unioloides, Humb.			x	·	
B. tectorum, L.			x		
B. sterilis, Ger.		x		x	
B. mollis, L.	x	x	x	x	
B. arvensis, L.			x	x	
Cynodon dactylon, L.		x	x	x	
Hordeum murinum, L.			x		
Juncus capitatus, Weig.	x			x	x
J. bufonius, L.	x		x	x	x
Zantedeschia aethiopica, Spreng.					x
Sparaxis tricolor, Ker.		x	x	x	
Romulea rosea, Eckl.			x		
R. parviflora, J. Britten			x		
Moraea xerospatha, MacOwen			x		
Homeria collina, Vent.		x	x		
Watsonia meriana, Mill.					x
Salix babylonica, L.					x
Urtica urens, L.			x		
Polygonum aviculare, L.		x	x		
Rumex crispus, L.	x	x	x	x	
R. acetosella, L.	x	x	x		
Silene gallica, L.			x	x	
Moenchia erecta, Gaertn.				x	
Stellaria media, L.			x	x	
Cerastium vulgatum, L.	x	x	x	x	
Sagina apetala, L.	x	x	x		
Papaver Argemone, L.			x		
Fumaria officinalis, L.		x	x		
Senebiera didyma, Pers.			..		
Potentilla anserina, L.				x	
Rubus fruticosus, L.	x				
R. laciniatus, Willd.	x				
Rosa rubiginosa, L.	x	x	x	x	

	A.	B.	C.	D.	E.
Crataegus oxyacantha, L.	x	x			
Ulex europaeus, L.	x	x		x	
Cytisus canariensis, Steud.	x			x	
C. scoparius, Link.	x				
Trifolium angustifolium, L.	x	x	x		
T. tomentosum, L.			x		
T. repens, Riv.	x	x	x	x	
T. procumbens, L.			x		
T. subterraneum, L.		x	x	x	
Medicago maculata, Willd.			x		
M. tribuloides, Desr.			x		
Geranium dissectum, L.	x	x	x	x	
G. molle, L.		x	x	x	
Erodium cicutarium, L.		x	x		
E. Botrys, Bertol.			x		
E. moschatum, L' Herit.		x	x		
O. cernua, Thunb.			x	x	
Malva parviflora, L.			x		
Hypericum perforatum, L.		x	x		
Foeniculum vulgare, Mill.	x			x	
Anagallis arvensis, L.	x	x	x		
A. coerulea, Lamk.	x	x	x		
Olea europaea, L.		x	x		
Buddleia Madagascariensis, Lam.	x				x
Erythraea centaurium, Pers.		x		x	
Vinca major, L.				x	
Gomphocarpus arborescens, R. Br.		x	x		
Convolvulus arvensis, L.			x		
Myosotis arvensis, Scop.			x		
Lithospermum arvense, L.		x	x		
Echium plantagineum, L.			x		
Verbena bonarensis, L.	x			x	x
Lavendula stoechas, L.		x	x		
Teucrium botrys, L.		x			
Lycium campanulaceum, Mey.			x	x	
Solanum sodomaeum, L. *			x	x	
S. nigrum, L.	x	x	x	x	
Verbascum virgatum, With.		x	x		
Bartsia latifolia, Sibth.			x		
Plantago lanceolata, L.	x	x	x	x	
Galium aparine, L.		x	x	x	
Scabiosa maritima, L.			x		
Erigeron, linifolius, Willd.		x	x		
Inula graveolens, Desf.	x	x	x	x	
Carduus crispus, L.	x	x			
Cirsium lanceolatum, Scop.	x	x		x	
Calendula arvensis, L.		x	x	x	
Cryptostemma calendulacea, R. Br.			x	x	
Hypochoeris glabra, L.	x	x	x	x	
H. radicata, L.	x	x	x	x	
Taraxacum officinale, Weber				x	
Picris hieracioides, L.	x				

Postscript.

Since the manuscript of this paper went to press the second part of the "Flora of South Australia," by J. M. Black (Adelaide: Government Printer, 1924), has appeared. This deals with the families Casuarinaceae-Euphorbiaceae. Certain changes in the nomenclature of some common plants have been made. Unfortunately it is not possible to incorporate them in the text, but the more important are indicated below. In the body of this paper the names of dicotyledonous plants are, as a rule, those used in the "Flora of Extratropical

South Australia" (R. Tate, 1890). The following list gives the names as used by us together with the names as revised:—

Drosera Menziesii, R. Br., becomes *D. Planchonii*, Hook. f.

Tillaea becomes *Crassula*. The species *T. verticillaris*, in the sense used in Bentham, "Flora Australiensis," is a composite of *Crassula colorata*, (Nees) Ostenf., and *C. Sieberiana*, (Schultes) Ostenf. Both of these in the Mount Lofty Ranges, but were not distinguished by us.

Acacia retinodes, Schlecht, should be spelled *Ac. rhetinodes*.

Eutaxia empetrifolia, Schlecht, becomes *E. microphylla*, (R Br) J. M. B.

Correa speciosa, Andr., becomes *C. rubra*, Sm.

Geijera parviflora, Lindl., in the sense used by Tate, included *G linearifolia*, (DC.) J. M. B. This is the species meant by us.

Tetratheca ericifolia, Sm., in the sense used by Tate, included *T. pilosa*, Labill. This is the species occurring in the Mount Lofty Ranges.

T. G. B O.

LITERATURE CITED.

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EXPLANATION OF PLATES X TO XX

Plate X.

Fig. 1. High forest of *Eucalyptus obliqua* with *Xanthorrhoea semiplana, Lepidosperma carphoides*, and occasional bushes of *Hakea rostrata, Isopogon, Astroloma, Hibbertia*, etc. Kuitpo, July, 1922. T. G. B. O., photo.

Fig. 2. Forest of young *Eucalyptus obliqua* with dense shrubby undergrowth of *Acacia myrtifolia, Pultanea daphnoides*, and very numerous shrubs. Mount Lofty, Dec., 1913. T. G. B. O., photo.

Platf XI.

Fig. 1. Regeneration of *Eucalyptus obliqua* after a fire 3-4 years previously, showing old trees shooting from dormant buds and numerous seedlings. Undergrowth of *Leptospermum myrsenoides* and numerous shrubs, *Lepidosperma*, etc. Mylor, Nov., 1922. R. S. A., photo.

Fig. 2. *Eucalyptus obliqua* forest about 7-8 months after a fire, showing regeneration from dormant buds and abundant flowering of *Xanthorrhoea semiplana* Near Mount Lofty, Oct., 1912. T. G. B. O., photo.

Plate XII. ....

Fig. 1. *Eucalyptus obliqua* regenerating about 3 years after a severe fire. Note numerous young trees and the abundance of *Ixodia achilloides* in flower foreground. Near Mount Lofty, Jan., 1913. T. G. B. O., photo.

Fig. 2. *Eucalyptus fasciculosa* on sunny quartzitic ridge locally replacing *Eucalyptus obliqua*. Dwarf undergrowth of *Hibbertia* and *Tetratheca*. National Park, Belair, May, 1913. T. G. B. O., photo.

Plate XIII.

Fig. 1. Dwarf scrub of *Eucalyptus capitellata* with *Xanthorrhoea semiplana, Banksia ornata*, etc., on glacial soils. Black Swamp, May, 1914. T. G. B. O., photo.

Fig. 2. Dwarf scrub of *Eucalyptus capitellata* on hills and gully forest of *Eucalyptus obliqua* following stream and widening out at its head waters, where *E. fasciculosa* becomes dominant. Near Mount Compass, Oct., 1922. T. G. B. O., photo.

Plate XIV.

Fig. 1. Stream-side community widening out into a swampy patch with *Phragmites* and *Typha*. The dense growth by the stream on the further side includes *Leptospermum lanigerum*. Right foreground and distance, *Eucalyptus obliqua* forest with *Xanthorrhoea, Acacia myrtifolia*, etc. Near Mount Lofty, Aug., 1922. T. G. B. O., photo.

Fig. 2. *Eucalyptus elaeophora* on ridge of Pre-Cambrian rock. Near Birdwood, Nov., 1922. R. S. A., photo.

Plate XV.

Fig. 1.. *Eucalyptus elaeophora* with undergrowth of *Lepidosperma semiteres* having the appearance of a tussock grass. Near Birdwood, Nov., 1922. R. S. A., photo.

Fig. 2. Open forest of *Eucalyptus leucoxylon* on lower slopes of Mount Lofty Range. In distance the crest of the main range is visible, Mount Lofty highest point on right; the dense timbering there is *Eucalyptus obliqua*. Some trees of *Eucalyptus viminalis* in foreground and along valley but not distinguishable from the blue gum. Near Adelaide, July, 1922. T. G. B. O., photo.

Plate XVI.

Fig. 1. *Eucalyptus leucoxylon* with undergrowth of young *Acacia pycnantha*. Clare, Nov., 1913. T. G. B. O., photo.

Fig. 2. Savannah forest of *Eucalyptus leucoxylon*, some *E. viminalis*. The undergrowth is chiefly herbaceous, including *Stipa, Danthonia*. The trees in the foreground have been ringbarked to improve the pasture. Birdwood, Nov, 1922. R. S. A., photo.

Plate XVII.

Fig. 1. Woodland of *Eucalyptus rubida* with undergrowth of *Acacia pycnantha* Ambleside, July, 1922. T. G. B. O., photo.

Fig. 2. Woodland of *Eucalyptus odorata* with grassy and herbaceous undergrowth. Near Kapunda, Oct., 1917. T. G. B. O., photo.

Plate XVIII.

Fig. 1. *Eucalyptus rostrata* growing by a waterhole in Inman Valley. Victor Harbour, Jan., 1920. T. G. B. O., photo.

Fig. 2. Swamp to left with *Eucalyptus rubida* and shrubby undergrowth, *Leptospermum scoparium*, etc To right hill slope with *Eucalyptus obliqua*. Mylor, Nov., 1922. R. S. A., photo.

Plate XIX.

Fig. 1. Extensive area of savannah forest, chiefly *Eucalyptus odorata*, ringbarked, trunks show white, and grazed. Photograph taken from crest of a ridge, tree to left foreground, *Casuarina stricta*, on shallow soil. Near Kapunda, Oct., 1917. T. G. B. O., photo.

Fig. 2. Dense growth of grasses, including *Themeda* and *Avena fatua*, 12 months after enclosing area against sheep. Hidden by grass are many tree seedlings. Foreground, this side of fence, grazing is allowed. Near Kapunda, Oct., 1917. T. G. B. O., photo.

Plate XX.

Fig 1. Impenetrable growth of *Rubus fruticosus, Cytisus canariensis*, and *Foeniculum vulgare* on silt-swamp land on banks of River Onkaparinga. The trees are *Eucalyptus rubida*. Mylor, Nov., 1922. R. S. A., photo.

Fig. 2 Natural regeneration of *Eucalyptus rostrata* on alluvial flat. This area was under cultivation 30-40 years ago; the plough marks can still be seen between the trees. Near Kuitpo, July, 1922. T. G. B. O., photo.

THE EXTERNAL CHARACTERS OF POUCH EMBRYOS OF MARSUPIALS.

No. 9.—PHASCOLOMYS TASMANIENSIS.

By Frederic Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read July 17, 1924.]

For the opportunity of examining the pouch young of the Tasmanian representative of the genus *Phascolomys* I am indebted to Prof Thomson Flynn, of the University of Tasmania. The R V. length of the specimen is 140 mm., and hair has made its appearance over the entire body, the hair pattern showing to the best possible advantage. In no outstanding feature does this young animal differ widely from the adult; and even much younger embryos, of other

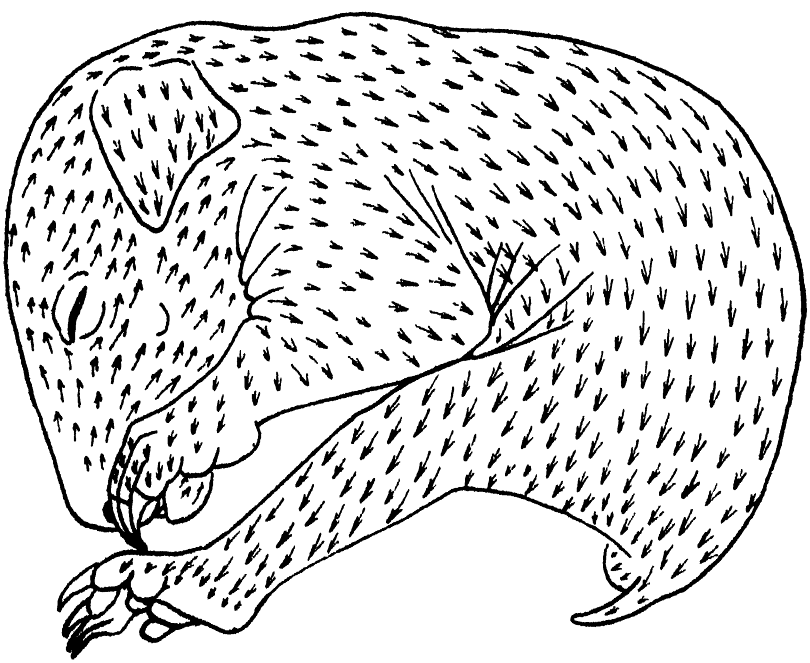

Fig 1
Phascolomys tasmaniensis
General external characters of the embryo showing hair tracts
Two-thirds natural size

members of the genus which I have examined, are remarkable for their unmistakable likeness to the mature animals. The specimen is a female and is the only example of its species available for examination

Hair Tracts.—The hair pattern over the whole of the head, body, and limbs is of basal simplicity; the primitive caudad and ventrad slope on the trunk, and the postaxial trend on the limbs, being everywhere preserved. This completely unaltered hair pattern in *Phascolomys* is worthy of note, since it differs so

entirely from the highly specialised condition present in *Phascolarctus* (see this series of papers, No. 5). Between *Phascolomys* and *Phascolarctus* there are some undoubted anatomical likenesses, and some authors have been, perhaps

Fig 2
Phascolomys tasmaniensis
Facial vibrissae. Half natural size

Fig. 3.
Phascolomys tasmaniensis
Characters of the rhinarium
Twice natural size.

unduly, impressed by these similarities. Before the superficial likenesses between the two animals influence our judgment as to their near kinship, we must certainly not disregard the total unlikeness of their hair pattern.

Sensory Papillae and Vibrissae.—All the facial sets are well developed (see fig. 2); the papillae being large and prominent, and the vibrissae, even at this

Fig. 4.
Phascolomys tasmaniensis
Characters of left auricle.
Twice natural size.

early stage, being coarse and stiff. There are five supraorbital vibrissae springing from a well-marked supraorbital papilla situated not far behind the anterior (inner) canthus of the eye. Seven stout and elongated genals arise from a large papilla which is also situated somewhat anterior to its usual position. The interramal papilla is large, elongated from side to side, and gives rise to about a dozen vibrissae, of which there are three long and three short bristles on each side. The mysticials are arranged in many (more than 6) rather ill-defined

rows, the individual vibrissae are long and coarse, the longest reaching well past the eye. The submentals are short and curved forwards. No definite papilla marks their site of origin.

Brachial Vibrissae.—The ulnar carpal papilla is well developed and it gives rise to a couple of stout bristles. No other vibrissae can be detected.

Rhinarium.—The naked area is extensive. The skin is almost smooth, the granulations being very ill-defined. The nostrils are slit-like and their lower naked margins are only slightly marked off from the hairy maxillary processes (see fig. 3). The apex of the naked wedge-shaped rhinarium is rounded and

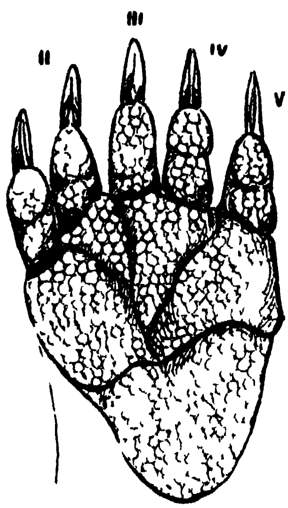

Fig. 5
Phascolomys tasmaniensis
Palmar aspect of left manus
Twice natural size

Fig. 6
Phascolomys tasmaniensis
Plantar surface of left pes
Twice natural size.

falls considerably short of the maxillary processes, so that the upper lip is deeply cleft in the middle line over the upper incisor teeth. There is no median groove on the rhinarium. There are no likenesses, save extremely superficial ones, to the rhinarium of *Phascolarctus*.

The External Ear.—The auricle is by no means the simple structure that the descriptions of Pocock would lead us to suppose. To speak, as this author does, of "the complete or almost complete disappearance of the supratragus" is quite incorrect, and such a statement can only have arisen from the examination of unsatisfactory material. Upon the mandibular portion of the helix there are two ill-defined tragoid projections (marked x x in fig. 4). The hyoid portion of the antihelix is complex and folded, with a well-marked processus antihelicis separated from a secondary process by a deep sulcus. The sculpturing of the auricle is considerably diminished in the adult animal, but if by "supratragus" the upper portion of the antihelix is meant, we can only admit that this structure has by no means disappeared.

The Manus.—The manus is relatively large and spatulate, bearing an obvious imprint of its adult application to the process of digging (see fig. 5). The whole palmar surface is naked and coarsely granulated. The pads are distinct. Digital

pad 1 is fused with the thenar pad. Digital pads 2, 3, and 4 are discrete. The hypothenar pad is large and constitutes the bulk of the proximal portion of the palm. The digits are short and strong, and armed with powerful curved claws. The digital formula is 3 > 4 > 2 > 5 > 1, as in the adult.

The Pes.—The pes shows an entirely naked and coarsely granulated sole, on which the pads are not distinctly delimited. Digit 1 is reduced to a nailless, fleshy knob. The syndactylous digits 2 and 3 are especially well developed (see fig. 6). The claws of digits 2, 3, 4, and 5 are curved and elongated, those of the syndactylous digits being the longest and most slender of the series. The digital formula is 2·3 > 4 > 5 > 1, as in the adult.

Pouch and Mammary Area.—The pouch is shallow at its cephalic and caudal ends; deepened laterally, especially behind, so as to be, at this stage,

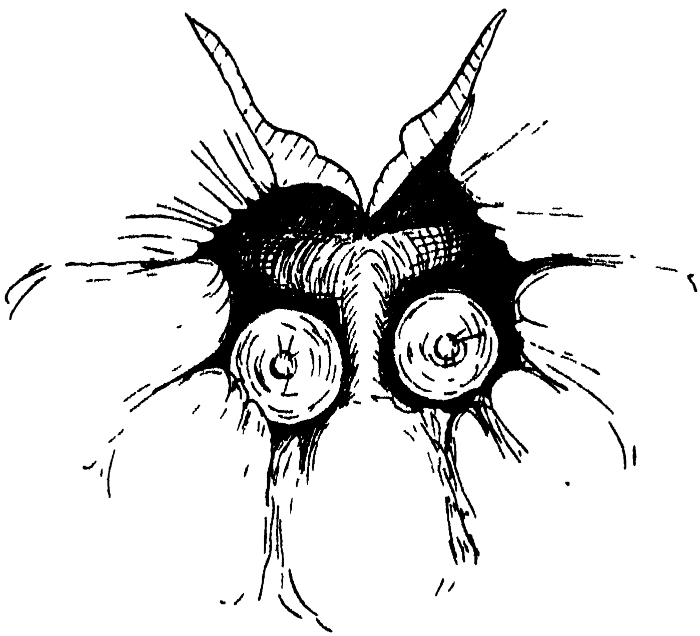

Fig. 7.
Phascolomys tasmaniensis
Pouch and nipples The anterior margin of the pouch has been slit, in order to open the mouth more completely.

distinctly bilocular. The orifice of the pouch is of a smaller diameter than the depth of the cavity only at the front and sides. At the posterior margin the skin surface of the abdomen merges gradually to the cavity of the pouch as a median elevation between the two mammary areas. This median elevation, which partly subdivides the cavity into right and left mammary pockets, spreads out on the floor of the pouch cephalad to the mammary areas, and so forms a torus which limits the mammary pockets anteriorly. The nipples themselves are very large and prominent, their apices protruding into the mouth of the unopened pouch Each nipple is in the shape of a little cone, and from its apex a few short bristle hairs project.

External Genitalia.—The tip of the genital tubercle is practically hidden within the prominent margins of the cloaca.

SOME NEW RECORDS OF FUNGI FOR SOUTH AUSTRALIA. PART III.

TOGETHER WITH A DESCRIPTION OF TWO NEW SPECIES OF PUCCINIA.

By Geoffrey Samuel, B.Sc.,
Lecturer on Plant Pathology, University of Adelaide.

[Read July 17, 1924.]

Plates XXI. and XXII.

Further new records of parasitic fungi occurring in South Australia are presented in this paper. These, together with the records listed in two previous papers (Osborn, 1915; Osborn and Samuel, 1922), and those to be found in MacAlpine's various books on Australian fungi, bring our knowledge of the parasitic fungus flora of this State up to date. A complete card index of all fungi recorded for the State, together with an index of host plants, has now been established in the Laboratory of Plant Pathology of the University, and records of distribution are continually being added.

Many of the fungi recorded in the present paper were collected by Prof. T. G. B. Osborn, and his valuable field notes have in many instances been incorporated in the text. Owing to his thorough collecting of fungi on his long journeys into the interior in connection with the ecology of the saltbush areas, we are gaining a much more complete knowledge of the fungi attacking plants of the arid regions. The aecidial stage in the life-cycle of three different rusts, and two new species of rusts, have thus been contributed by him, and are now described for the first time. One of these new rusts the author has pleasure in naming after him.

It is also a pleasure to record the gift to the Laboratory of Plant Pathology of the University, by Prof. J. B. Cleland, of his herbarium of parasitic fungi collected in Australia. Several new records for the State of South Australia were contained in this collection, and these have been incorporated in the present paper.

The paper adds sixty records to the host index of South Australia, and twenty-three of these involve fungi not hitherto recorded for the State. The majority of the fungi listed are plant parasites, most of them indigenous. The record of their occurrence in this State means an extension of our knowledge of their geographical range in Australia. There is undoubtedly much still to be learnt in this direction, however, for practically every excursion into the country yields some new specimen. Our knowledge of the saprophytic fungi which occur in South Australia, even of such easily visible forms as many bark-dwelling Ascomycetes, is as yet negligible.

Attention may be called to the following new descriptions. The aecidial stage is described for the first time for *Puccinia kochiae, Uromyces atriplicis,* and *Uromyces vesiculosus*. The last of these is particularly interesting, as the aecidia were only found on the cotyledons and hypocotyl of young seedlings, and the bearing of this on the life-history of the fungus is discussed. In each of these three cases the connection between the aecidia and the rusts in question has been assumed from the two stages having been found together on the same

plants. No experimental evidence of connection was attempted. The spermogonia of *Puccinia morrisoni* on *Pelargonium australe* are described. Two new species of *Puccinia* are described, one occurring on members of the genus *Bassia*, and the other on *Olearia rudis*. The writer is indebted to Mr. C. C. Brittlebank, of the Department of Agriculture of Victoria, for comparing the two new species of rusts with material on related hosts in the herbarium of the Department in Melbourne.

Uromyces salsolae, Reich., has not been recorded for Australia before

Seven of the fungi listed were collected near Broken Hill, in New South Wales, on a trip which Prof. Osborn made in 1918, and some of them are new records for that State also. They are the following.—*Puccinia bassiae*, *P. calotidis*, *P. tasmanica*, *Uromyces salsolae*, *Uromycladium tepperianum*, *Ustilago comburens*, *Erysiphe cichoracearum*.

Following the arrangement of the previous lists, reference is given to MacAlpine's Systematic Arrangement of Australian Fungi, by the number assigned there, and also, where possible, to other of MacAlpine's works, in order to render it easy to ascertain the range of a species in other States.

UREDINEAE.

PUCCINIA AUCTA, Berk. and F. v. M. III. On leaves, stems, and fruit-vessels of *Lobelia anceps*, L. Cape Jervis Peninsula, Jan., 1924, J. G. Wood Aecidia have been found on various Lobelias in the Eastern States, but teleutospores have been described only from one collection in South Australia, which bore no aecidia. As these spore forms occurred (separately) on the same species *(L. anceps)*, MacAlpine considered it justifiable to unite the two under the name *Puccinia aucta*. It is curious that teleutospores have again been found in South Australia with no aecidia, and that teleutospores have not yet been reported from the Eastern States where the aecidia occur. It seems just possible that there may be no connection between the teleutospore rust in South Australia and the aecidia found on Lobelias in the Eastern States. .

Cunningham also finds teleutospores only present in New Zealand, and considers that there is no connection between these and the aecidia.

The teleutospores on the present specimen were extremely variable (fig. 1). Three-celled teleutospores were common; the development of a small upward-growing process from the lower cell was frequent; two teleutospores on one stalk were seen in one instance; numerous types of deformation were to be met with on all the specimens. It is possible that the sori were infected with *Darluca filum;* this parasite was observed on the sori on a few plants, but could not be detected on those from which the figures of spores were drawn.

Teleutospores brownish-yellow, average $60\text{-}70 \times 20\text{-}25\ \mu$; when triseptate may reach a length of $100\ \mu$. (McAlp., 1906, p. 148.)

Puccinia bassiae, n. sp.

I. Aecidia in small clusters on the cylindrical-clavate, often woolly, leaves. Pseudoperidia white, reflexed and laciniate at the margin; peridial cells oblong, angular, variable, densely punctate and finely striate at the margin, $24\text{-}45 \times 22\text{-}30\ \mu$. Aecidiospores subglobose to polygonal, orange, $21\text{-}28\ \mu$ diam.

II. Uredosori amphigenous, circular or elliptical, up to 1 mm. in diam., surrounded by the ruptured epidermis, convex, brown; uredospores subglobose to oval, yellowish to yellowish-brown, with numerous germ-pores (5 to 10) on each face, $23\text{-}36 \times 21\text{-}25\ \mu$, average $27 \times 23\ \mu$.

III. Teleutosori mainly on stems, variable in size from $\frac{1}{2}$ to 4 mm., usually aggregated on definite lesions and bursting the cortex, elongated, compact, black.

Teleutospores densely packed, elliptic-oblong, rounded at both ends, smooth, deep chestnut-brown, slightly constricted at the septum, 32-46×20-31 μ, average 38×23 μ. Pedicel persistent, slightly tinted, variable in length to over 100 μ.

X. Mesospores rare.

I., II., III. On *Bassia paradoxa*, (R. Br.) F. v. M. Stephens Creek, near Broken Hill, N.S. Wales, Aug., 1918, T. G. B. O (fig. 2).

II., III. On *Bassia uniflora*, R. Br. Stephens Creek, Aug., 1918, T. G. B. O.

II., III. On *Bassia decurrens*, J. M. Black. Stephens Creek, Aug., 1918.

II., III. On *Bassia obliquicuspis*, R. H. And. Silverton, N.S. Wales, Aug., 1918, T. G. B. O.

II. On *Bassia uniflora*, R. Br. Beltana, South Australia, May, 1920, T. G. B. O.

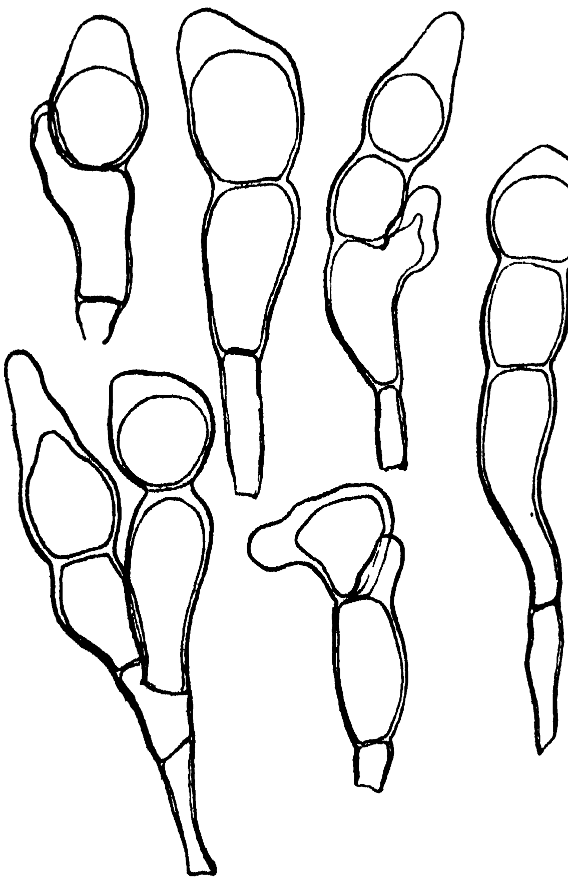

Fig. 1.
Puccinia aucta, Berk. and F. v. M.
Teleutospores showing abnormalities
(×610)

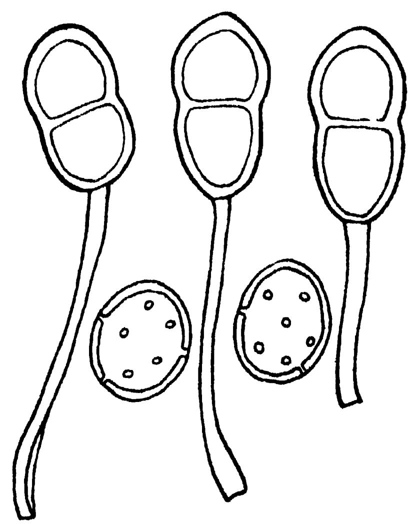

Fig 2.
Puccinia bassiae, n. sp.
Uredospores and teleutospores
(×610).

One cannot but be struck by the resemblance of this rust to *Puccinia kochiae*, Mass., and yet the two can always be recognised apart. The teleutospores of the rust on *Bassia* are rather smaller and darker brown, and slightly more constricted at the septum, and the uredospores are smaller and more globular than

those of *Puccinia kochiae*. On the other hand, the form of the teleutospores is practically the same as in the Kochia rust, and the numerous germ-pores on the uredospores are a characteristic feature in both. Such resemblances would suggest that one of these rusts has arisen from the other. Although species of these two genera of host plants frequently grow intermixed, no specimens of both rusts collected in the same locality have yet been received It therefore seems justifiable to place the new rust on *Bassia* in a separate species.

PUCCINIA BROMINA, Eriks. II., III. On *Bromus maximus*, L. Mylor, Nov., 1922, T. G B. O. (McAlp., 1906, p. 116.)

PUCCINIA CACAO, McAlp., II. On *Rottboellia compressa*, L. Inman River, Jan., 1924, J. B. C. (McAlp., 1906, p. 117.)

PUCCINIA CALOTIDIS, McAlp. I, III., X. On *Calotis hispidula*, F. v M. Stephens Creek, near Broken Hill, N.S. Wales, Aug., 1918, T. G. B. O The fungus was very common on its host in claypans. Also on *Calotis cymbacantha*, F. v. M. Curnamona, Aug., 1923, T. G. B. O Both these are new host species for the fungus (McAlp., 1906, p. 152.)

PUCCINIA CYNODONTIS, Desm. II. On *Cynodon dactylon*, Pers Inman Valley, Jan., 1922, T. G. B. O. Uredospores all of the subglobose, nearly smooth, thick-walled type. (McAlp., 1906, p. 118.)

PUCCINIA DAMPIERAE, Syd. I. On *Dampiera lanceolata*, A. Cunn. Halidon, Nov., 1918, W. J. Spafford. This is a new host species for the fungus (McAlp., 1906, p. 146.)

PUCCINIA GRAMINIS, Pers. II., III. On *Lolium perenne*, L. Forest Range, Feb , 1924, G. S. *Lolium* is not recorded as a host by MacAlpine, though known in Europe. Uredosori abundant on the green leaves, and teleutosori abundant on last year's dried inflorescence stalks. Also III., on *Hordeum murinum*, L. Pinnaroo, April, 1924, G. S. (McAlp., 1906, p. 120.)

PUCCINIA HYPOCHOERIDIS, Oud. III. On *Hypochoeris glabra*, L. Pinnaroo, Nov., 1923, G. S. Common among thin wheat crops. (McAlp., 1906, p. 159.)

Puccinia kochiae, Mass. I., II., III., X. On leaves and stems of *Kochia triptera*, var. *erioclada*, Benth. Ooldea, Aug., 1923, T. G. B. O. (fig. 3)

The aecidial stage of this rust, which has not been described before, was found in abundance on patches of this new host plant just within the sandhills bordering the Nullarbor Plain. The uredosori and teleutosori are described by MacAlpine as being amphigenous, discoid, up to 1 mm. diam. In the Ooldea specimens a most noticeable feature was the large, compact, erumpent teleutosori on the stems (fig. 3), up to 4 cms. in length. Small discoid sori also occurred on the leaves. In a specimen of this rust on *Kochia villosa*, kindly sent us by Mr C. C. Brittlebank from Victoria, there are large erumpent uredosori on the stems It seems probable that such uredosori might later become teleutosori, and that the Ooldea specimens, if they had been collected earlier, would have shown uredosori on the stems. The spore measurements of our specimens are slightly larger than those given by MacAlpine, but as the form of the uredospores and teleutospores agrees exactly there seems no justification for separating the fungus as a new species.

I. **Aecidia** in clusters, projecting on all sides of the cylindrical-clavate leaves, elongated, cylindrical, up to ¾ mm. long, with recurved, laciniate margin. Pseudoperidia smooth, white, appearing orange in the tubular portion owing to the aecidiospores within; peridial cells oblong, polygonal, many almost rectangular, thick-walled, densely punctate, with striate margins, 28-45×23-36 μ, average 40×27 μ. Aecidiospores subglobose to polygonal, 22-31 μ diam.

II. Uredosori amphigenous, discoid, compact, slightly convex, surrounded by the ruptured epidermis, up to 2 mm. diam., reddish-brown; uredospores elliptical, golden-brown, with numerous germ-pores (5 to 10) scattered over each face, 30-40×22-30 μ.

III. Teleutosori on leaves discoid, compact, convex, up to 3 mm. diam., deep brown-black; on stems forming black erumpent cushions up to 3 cms. long, divided by strands of the ruptured cortex The swellings caused by these teleutosori on the stems may attain a diameter two to three times that of the healthy stem, so that they may almost be described as galls. Teleutospores densely packed, often intermixed with uredospores, elliptic-oblong, rounded at both ends, in some spores so much thickened at the apex that the upper cell is almost obliterated, smooth, chestnut-brown, scarcely or not constricted at the septum,

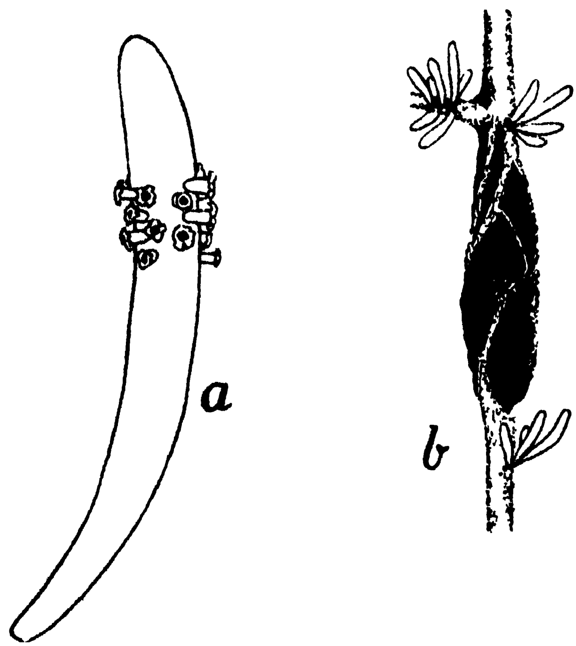

Fig. 3.
Puccinia kochiae, Mass. *a*, Accidia on leaf (×6).
b, Teleutosorus on stem (×1½) Semi-diagrammatic

40-50×27-35 μ, average 45×29 μ. Pedicel persistent, slightly tinted, variable in length from very short up to 100 μ.

X. Mesospores rare.

Also II., on *Enchylaena tomentosa*, R. Br. Port Elliot, Jan., 1919, T. G. B. O. Sceales Bay, West Coast, Jan., 1922, T. G. B. O. (McAlp., 1906, p. 176.)

Puccinia lolii, Niels. II., III. On *Holcus lanatus*, L. Forest Range, Feb., 1924, G. S.

Puccinia lolii, Niels., and *Puccinia coronata*, Cord., are both "crown rusts," with finger-like processes from the tops of the teleutospores. In Europe *P. lolii* has its aecidial stage on *Rhamnus cathartica*, and *P. coronata* has aecidia on *Rhamnus frangula*. Grove (p. 254) says: "The two rusts occur on different grasses, except that both are found on the two species of *Holcus*. Aside from the distinction of hosts they can be separated only by minute differences. When they occur on *Holcus*, therefore, the only test that could absolutely decide the

matter would be to await the maturation of the teleutospores, and then try which of the two species of *Rhamnus* they would infect."

As *P. lolii* has been recorded for this State before, and as *P. coronata* is not listed by MacAlpine for Australia, the present specimens are assigned to the former, as being the most probable. The bright orange uredosori were literally covering the leaves; teleutosori were beginning to be formed. (McAlp., 1906, p. 123.)

PUCCINIA LONGISPORA, McAlp. II., III. On *Carex gaudichaudiana*, Kunth. Mylor, Nov., 1922, T. G. B. O. (McAlp., 1906, p. 135.)

Puccinia Morrisoni, McAlp. O., I., II., III., X On *Pelargonium australe*, Jacq. Port Noarlunga, May, 1924, Miss I. Davies

All stages of this rust were found on wild *Pelargonium* in a deep, sheltered hollow in the sandhills. MacAlpine records aecidia only from one locality, the Murramurrangbong Ranges; he does not mention spermogonia, so that the following additional notes may be given.

Spermogonia appearing first on slightly yellowish spots (2 to 5 mm. in diam.) on the leaves; spermogonia minute, punctiform, clustered, orange-brown, becoming black, amphigenous, though often on the upper surface only, 130-150 μ diam. Spermatia minute, oval, 2-3 μ. Aecidia arising later in clusters beneath spermogonial groups, occasionally amphigenous, and intermixed with, or surrounding, the spermogonia. Uredosori scattered, amphigenous; in these specimens even more frequent on the upper than the under surface. (McAlp., 1906, p. 180.)

Puccinia Osborni, n. sp.

I. Aecidia amphigenous, usually in clusters on slightly yellowish spots on the leaves; on older leaves infected tissue sometimes dries so that aecidia are left seated on circular dead spots 4-8 mm. diam Pseudoperidia cup-shaped, scarcely projecting, with small white, fringed margin; peridial cells firmly united, overlapping, slightly elongated, polygonal, punctate with striated margin, $20\text{-}25 \times 15\text{-}20\ \mu$. Aecidiospores subglobose to polygonal, orange-yellow, smooth, $14\text{-}18 \times 13\text{-}16\ \mu$.

III. Teleutosori frequently surrounding aecidial groups in a single circle, sometimes less regularly placed, intermixed; black to blackish-brown, long covered by epidermis, compact, round to elongated, sometimes confluent, pulvinate, ca. $\frac{1}{2}$ mm. diam.

Teleutospores variable, oblong to clavate, chestnut-brown, upper cell darker than the lower, constricted at the septum, smooth, $30\text{-}54 \times 18\text{-}25\ \mu$, average $45 \times 22\ \mu$; occasionally tricellular, when up to 65 μ long. Upper cell deep chestnut-brown, rounded, or somewhat ovate, conoid or truncate, rather variable, considerably thickened at the apex; lower cell lighter in colour, of lesser diameter, tapering at the base, or sometimes rounded, on the average about the same length as the upper cell, though often relatively elongated. Pedicels persistent, hyaline to pale yellow, usually $\frac{1}{2}\text{-}\frac{3}{4}$ the length of the spore.

X. Mesospores occasional, deep chestnut-brown, clavate, thickened at the apex, $35\text{-}40 \times 20\text{-}27\ \mu$.

On *Olearia rudis*, F. v. M. (syn. *Aster exul*, Lindl.), var. *glabriuscula* (fig. 4).

Two rusts are recorded on Olearias by MacAlpine: *Puccinia oleariae*, McAlp. (II., III., X.), on *O. argophylla* and *Aecidium oleariae*, McAlp. (I.), on *O. axillaris*. The present rust differs from the former in having aecidia and no uredospores, being of the I., III., X. type, like *P. saccardoi* and *P. tasmanica*, in which the teleutospores are formed intermixed with or surrounding the old aecidia, on the same mycelium. The teleutospores, moreover, bear no resemblance

to those of *P. oleariae*. It differs from the latter in that teleutospores have never been found to follow the aecidia in *Aecidium oleariae*, which is probably, though not necessarily, a "two-cycle" rust of which the II., III. stage has not yet been discovered. I., III., X. rusts do sometimes produce aecidia after aecidia several times, however, so that it is possible that teleutospores may later be found intermixed with the aecidia of *Aec. oleariae*. The aecidia, peridial cells and aecidiospores of the present rust, however, are all considerably smaller than those of *Aec. oleariae*, the pseudoperidium is not so strongly reflexed and laciniate, and the aecidia are usually in circular spots on the leaves, and not embedded in a woody stem as in *Aec. oleariae*. These considerations seem amply sufficient to warrant the placing of this rust in a new species.

Two other rusts (*Puccinia Atkinsonii*, G. H. Cunn., on *Olearia excorticata*, Buch., and *Puccinia novae-zealandiae*, G. H. Cunn., on *Olearia Forsteri*, Hook. f.) have been described on Olearias by Cunningham in New Zealand, but both differ from the present specimens.

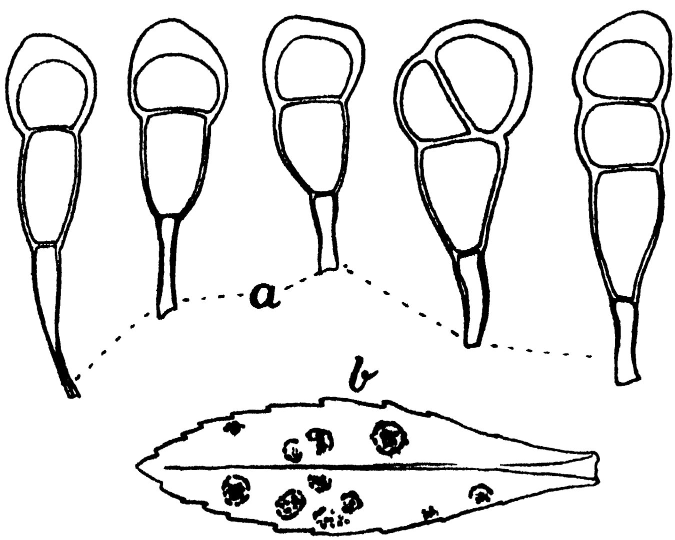

Fig. 4.

Puccinia Osborni, n. sp. *a*, Teleutospores (×610) *b*, Aecidia and teleutosori on leaf of *Olearia rudis*, F v M, var *glabruscula*
(Nat. size)

Rusts bearing a considerable morphological resemblance to one another have been described on several members of the family Compositae. As examples may be cited *Puccinia tasmanica*, *P. erechtites*, *P. vittadineae*, *P. calotidis*, the new rust *P. osborni*, and perhaps *P. calocephalus* and others. How far they may be identical could only be proved by cross-inoculation experiments. Meanwhile it is a matter of convenience to name those on genetically separated genera as different species.

It seems quite possible that some of these rusts have had a common origin, and that they may now be biologically specialized towards their respective hosts; perhaps also the beginnings of morphological specialization could be established by a thorough comparative examination. It is probable that more affinity would be found between those occurring on the more closely related host-genera. *Senecio* and *Erechthitis* both fall in the sub-section *Astereae-Asterinae* of the Compositae;

Vittadinia, Olearia, and *Calotis* are in the *Senecioniae-Senecioninae; Calocephalus* is in the *Inuleae-Angianthinae.*

It may be noted also that both MacAlpine and Brittlebank remark that it is strange that a new rust *(Puccinia tasmanica)* should have been found on an introduced weed *(Senecio vulgaris)* in Australia, and it would suggest that a native rust had crossed over to this host. Our knowledge of such "jumps," and of the degree of biological and morphological specialization which may follow them, is still almost negligible.

PUCCINIA SACCARDOI, Ludw. I., III. On leaves and peduncles of *Velleya paradoxa,* R. Br. Belair, Oct., 1922, G. S.

Also on leaves and stems of *Scaevola microcarpa,* Cavan. Belair, Nov., 1912, T. G. B. O.; Mount Lofty, June, 1924, J. B. Cleland. This rust has not yet been recorded on the genus *Scaevola,* MacAlpine giving only *Goodenia* and *Velleya* species as hosts. It seems to be comparatively rare on this host, as it has only been collected twice, though occurring close to Adelaide In the first specimen *Darluca filum* was parasitic on the aecidial patches, even fruiting within the aecidial cups. (McAlp, 1906, p. 147.)

PUCCINIA SUBNITENS, Diet. II On *Distichlis spicata,* (L.) Greene (syn. *D maritima,* Rafin) Hindmarsh River, Jan, 1923, T G. B O Uredospores only present; these correspond exactly with the description given by MacAlpine for this species, except that the uredosori are all epiphyllous, while MacAlpine describes them as hypophyllous. In this connection it may be remarked that the sides of the leaves of *Distichlis spicata* curve together over the upper surface on drying, instead of over the lower, as is the case in the majority of grasses (McAlp., 1906, p. 131.)

PUCCINIA TASMANICA, Diet. I, III On *Senecio brachyglossus,* F. v M Stephens Creek, near Broken Hill, N S Wales, Aug., 1918, T G. B O III, on *Senecio brachyglossus,* F v. M. Pinnaroo, Nov., 1923, G. S. I, III, on *Senecio lautus,* Sol. Pinnaroo, April, 1924, G. S. (McAlp., 1906, p. 163.)

PUCCINIA XANTHOSIAE, McAlp II., III., X. On *Xanthosia pusilla,* Bunge. Mount Lofty, Mar., 1924, J B. Cleland. Uredospores somewhat smaller than MacAlpine's measurements; average 31×22 μ. Teleutospore pedicels also longer, about 40 μ.

Uromyces atriplicis, McAlp. I., III. On leaves, petioles, and fruit capsules of *Atriplex vesicarium,* Haw. Coonamore, Aug., 1923, T. G. B. O. plate xxi., fig. 1).

The aecidia of this rust have not been described before They were found in great abundance all over certain bushes of the above host-plant, while surrounding bushes showed only teleutosori. There were also teleutosori on the bushes bearing aecidia. The growth of the aecidia-bearing bushes was rather abnormal, being more sappy than that of normal bushes, having more axillary shoots, giving a sort of witches-broom appearance, and having many of the fruit capsules enlarged and deformed. Aecidia were present in about equal abundance all over the bushes, practically every leaf being covered by them. These observations would suggest that the aecidium-bearing mycelium might be perennial, eventually permeating the whole plant. This stage of the fungus seems to be rare, however.

It is curious that uredospores were not found, but it is possible that this may be a matter of the age of the sori, and that if the fungus had been collected some months earlier uredospores might have been present.

I. **Aecidia** scattered fairly evenly over the whole of the under surface of practically every leaf on infected plants, $\frac{1}{2}$ to $\frac{3}{4}$ mm. diam., but often smaller towards the edges of the leaves; at first papillate, then bursting at the apex; the

white pseudoperidium at first incurved, but gradually becoming recurved and fimbriate with age. Peridial cells irregularly packed, polygonal, densely punctate and striate at the margins, 30-45×22-31 μ. Aecidiospores orange, subglobose to broadly elliptical, 20-30×17-22 μ, average 25×21 μ.

III. Teleutosori on plants bearing aecidia, or on plants with no aecidia, amphigenous, minute, compact, surrounded by the ruptured epidermis, deep reddish-brown, sometimes appearing almost black, up to 1 mm. diam. Teleutospores subglobose to shortly ellipsoid, finely striated longitudinally, slightly thickened at the apex, with prominent single apical germ-pore, dark-brown, 22-30×20-27 μ, average 26×25 μ. (McAlp., 1906, p. 100.)

UROMYCES PHYLLODIORUM, (B. and Br.) McAlp. II On phyllodes of *Acacia penninervis*, Sieber. (pl. xxi., fig. 2). The uredosori surround the spermogonia, being seated on swollen tubercles, as in the original specimens from Queensland. MacAlpine says that in Victorian specimens spermogonia are wanting, the uredosori being scattered over the surface of the phyllode. (McAlp. 1906, p. 95.)

UROMYCES SALSOLAE, Reich. II., III. On *Salsola kali*, var *strobilifera*, Benth. Near Broken Hill, N.S. Wales, Aug., 1918, T. G. B. O. On *Salsola kali*, L. Corona, N.S. Wales, Aug., 1921, Miss M. Collins. Also at Curnamona and Koonamore, South Australia, Aug., 1923, T. G. B. O.

Uredosori and teleutosori on leaves and stems, circular or elliptical, up to 1 mm. or more in diam., surrounded by the ruptured epidermis; the former brown, the latter almost black. Uredospores broad oval to slightly tapering, yellowish, finely echinulate, 20-30×14-18 μ, average 25×17 μ. Teleutospores globose to broad elliptic or clavate, usually thickened at the apex, dark bay-brown, smooth, on long persistent pedicels; 20-30×17-22 μ, average 25×20 μ. Pedicels pale yellow, 60-110 μ, average 90 μ.

This rust is not recorded by MacAlpine, and is therefore a new record for Australia. It is given in Sydow's Monographia Uredinearum as being fairly widely distributed in Europe. It seems more probable that it is an indigenous rust here which has long been present in our arid districts, but overlooked on account of its inaccessibility, than that it has been introduced. The teleutospores are slightly smaller and darker than those of European specimens, but these differences are so small as not to warrant any separation of the present species from the European one.

Uromyces vesiculosus, Wint. I., II., III., X. On *Zygophyllum ovatum*, Ewart. Koonamore, Aug., 1923, T. G. B. O. (fig. 5, and pl. xxi., fig. 3).

The aecidia of this rust have not been described before. They were found only on the cotyledons and stem-bases of young plants, which were heavily infected, however, with the uredospore and teleutospore stage on the later leaves and stems. As the cotyledons drop off after a little while, this probably explains why the aecidia have not been collected before.

This mode of occurrence of the spore forms suggests that the life history of the fungus is probably as follows:—The teleutospores are the resting or "over-summering" stage, for the host plant grows in arid regions, coming up from seed at the first winter rain. The teleutospores probably germinate at the same time as the seeds of the host plant, infection occurring while the seedlings are still very young. The haploid phase of the fungus initiated thus fructifies as aecidia on the cotyledons or hypocotyl, the resulting aecidiospores serving to infect the later leaves and stems, giving rise there to the diploid phase of the fungus which soon produces uredospores, and later teleutospores to over-summer again. This is an interesting life-history illustrating the tiding over of the unfavourable growing period of the dry summer of arid regions instead of the cold winter, as in most instances studied.

I. **Aecidia** on cotyledons, on hypocotyl or stem just above, or rarely on youngest leaves; pseudoperidia white, cup-shaped, with reflexed, fringed margin; when on stems projecting as almost cylindrical or narrow bell-shaped receptacles ½-¾ mm. long; peridial cells oblong to angular, finely striated, 30×45 μ long; aecidiospores subglobose to angular, orange, 20-26 μ diam.

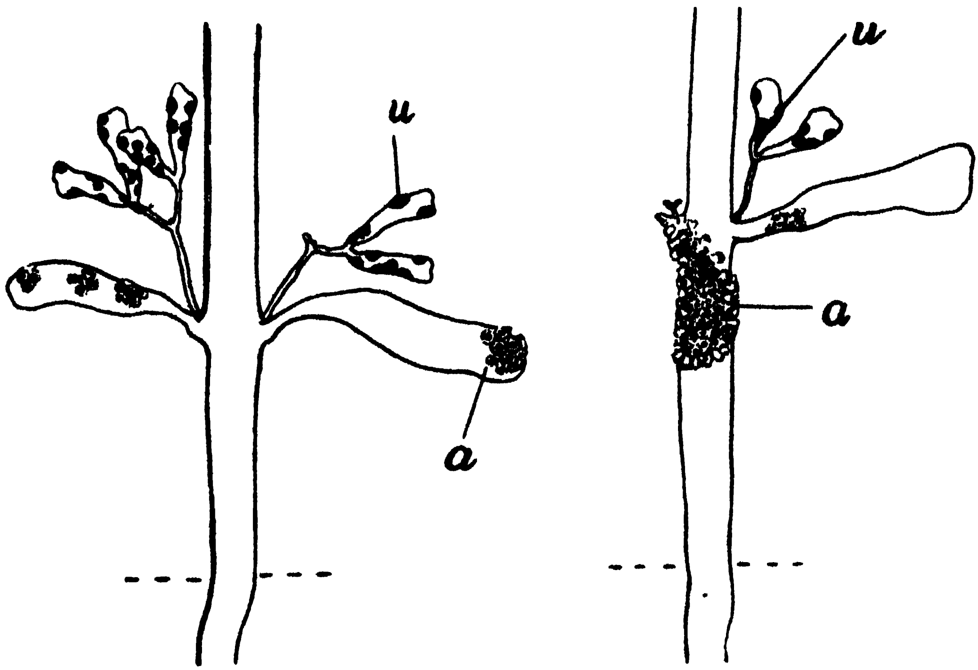

Fig 5.

Uromyces vesiculosus, Wint. Bases of two seedlings, showing aecidia *(a)* on cotyledons and hypocotyl, and uredosori *(u)* on small axillary shoots Semi-diagrammatic; drawn from dried material (×2)

The uredospores on the present specimens were considerably longer (28-42 × 15-21 μ, average 35-18 μ) than those whose measurments MacAlpine gives; they were also much less spiny than one is led to expect from his description. As the teleutospores, and the macroscopic appearance of uredosori and teleutosori in the present specimens agree with MacAlpine's description of *Uromyces vesiculosus,* however, the above differences in the uredospores do not seem of sufficient weight to separate the fungus from this species. (McAlp., 1906, p. 103.)

Uromycladium notabile, (Ludw.) McAlp. II. On twigs of *Acacia dealbata,* Link. Aldgate, Jan., 1924, C. H. Beaumont. (McAlp., 1906, p. 108.)

Uromycladium tepperianum, (Sacc.) McAlp. On *Acacia aneura,* F. v. M. Near Broken Hill, N.S. Wales, Aug., 1918, T. G. B. O.; Beltana, Aug., 1921, J. B. Cleland; Koonamore, Aug., 1923, T. G. B. O. (pl. xxii., fig. 1). On *Acacia bynoeana,* Benth. Nunkeri, May, 1921, T. G. B. O. On *Acacia decurrens,* Willd. (cultivated). Aldgate, Mar., 1924, C. H. Beaumont. On *Acacia ligulata,* A. Cunn. Ooldea, Aug., 1922, T. G. B. O. (pl. xxii., fig. 2). On *Acacia linophylla,* W. V. Fitzg. Ooldea, Aug., 1922, T. G. B. O. On *Acacia obliqua,* Cunn. National Park, Sept., 1922, T. G. B. O. On *Acacia penninervis,* Sieb. Cowra Landing, Jan., 1922, T. G. B. O. On *Acacia rigens,* A. Cunn.

Monarto South, May, 1921, J. B. Cleland. On *Acacia tetragonophylla*, F. v. M. Lakes Grave; Umberumberka; Broken Hill District, N.S.W., Aug., 1918, T. G. B. O. Beltana, Aug., 1921, J. B. Cleland; Kingoonya, Aug., 1923, T. G. B. O. (pl. xxii., fig. 3). On *Acacia trineura*, F. v. M. Alawoona, Dec., 1913, J. B. Cleland. On *Acacia verticillata*, Willd. Myponga, Dec., 1923, J. B. Cleland.

Nine of the above are new host species. The list of hosts for this fungus is continually increasing in length, and now comprises about thirty different species of Acacia of the most diverse habit and habitat. On the one hand there are Acacias from moist temperate rain-forests, such as *A. melanoxylon* and *A. decurrens*, while, on the other, are dwarf and spiny forms from the most arid desert regions in Central Australia, for example *A. tetragonophylla*, the "dead-finish bush."

The type of gall produced by the fungus on these different hosts also varies widely. A number of types are well illustrated in MacAlpine's Rusts of Australia; other examples from the above host list are illustrated in the plate accompanying this paper. The knobby galls formed on *Acacia aneura*, the "mulga," frequently cause the gradual death of the shoot beyond the infected part, and a progressive diminution in size of the gall-knobs seems to indicate the slow starvation of the fungus as the shoot dwindles away. On *Acacia tetragonophylla* the reddish-brown sori of the fungus burst out along the small twigs usually without the pronounced gall-formation characteristic of the reaction of most other Acacias; the infected twigs often contrast sharply, on this account, with the silver-grey healthy shoots. At the same time there is often a pronounced development of small witches' brooms.

This great range of infection of *Uromycladium tepperianum* cannot but raise doubts as to the physiological homogeneity of this species. Field observations on the fungus only increase these doubts. For instance, at Ooldea, on the sandhills at the edge of the Nullarbor Plain, *Acacia ligulata* and *Acacia linophylla* are to be found growing together in many places. The Uromycladium galls were found affecting many bushes of *A. ligulata* in a more or less definite, but circumscribed, area near Ooldea Soak. In this area the *A. linophylla* was not affected. In the area where the galls on *A. linophylla* were found the *A. ligulata* was not affected. This cannot but suggest that the fungus affecting one is not cross-inoculable to the other, although morphologically the two fungi are identical in every respect, and referred to the one species, *Uromycladium tepperianum*. Similar observations have frequently been made in the case of other host species growing intermixed; *A. pycnantha* and *A. armata* furnish one example, out of a number that could be cited. It is suggested, therefore, that *Uromycladium tepperianum* may be divisible into a number of "biologic species," each adapted to different species, or groups of species, of *Acacia*. No proof has been advanced for this, but it is hoped to do some experiments on it later on. (McAlp., 1906, p. 111.)

USTILAGINEAE.

Cintractia distichlydis, McAlp. On *Distichlis spicata*, (L.) Greene (syn. *D. maritima*, Rafin.). Hindmarsh River, Jan., 1923, T. G. B. O. (McAlp., 1910, p. 169.)

Sorosporium piluliformis, (Berk.) McAlp. On *Juncus planifolius*, R. Br. Mylor, Nov., 1922, T. G. B. O. Also on *Juncus caespiticius*, Meyer. Cape Jervis Penins., Jan., 1924, G. S. The latter is a new host species for the fungus, but is very closely allied to *J. planifolius*. Sori ashy-grey from the numbers of colourless sterile cells among the spores. (McAlp., 1910, p. 180.)

TILLETIA FUSCA, Ell. and Ev On *Festuca myuros*, L. Pinnaroo, Nov., 1923, G S. MacAlpine records this fungus only on *F. bromoides*, and says: "Although the silver-grass is widely distributed, I have not met with this smut but in one locality (Angustown, Victoria)" It was only found in one patch at Pinnaroo, but is not conspicuous, and might easily be overlooked (McAlp., 1910, p. 190.)

TOLYPOSPORIUM BURSUM, (Berk) McAlp On *Anthistiria ciliata*, L. f. Inman Valley, Jan., 1922, J. B Cleland. (McAlp, 1910, p. 186.)

TOLYPOSPORIUM JUNCOPHILUM, McAlp On *Juncus pauciflora*, R Br. Cape Jervis Penins, Jan, 1924, J G. Wood. (McAlp., 1910, p. 188)

USTILAGO BROMIVORA, (Tul) F. v M. On *Bromus unioloides*, H B and K Mylor, Nov, 1922, J. B. Cleland. Cresswell Gardens, Adelaide, Nov. 1922, G S (McAlp, 1910, p 150.)

USTILAGO COMBURENS, Ludw Destroying inflorescence of *Danthonia penicillata*, (Labill) F. v. M Near Broken Hill, N.S. Wales, Aug, 1918, T. G. B O. (McAlp., 1910, p. 153.)

Ustilago hydropiperis, var. *columellifera*, Tul. On *Polygonum lapathifolium*, L. Near Adelaide, June, 1919, W. J Spafford (McAlp, 1910, p 156)

ASCOMYCETES.

ERYSIPHE CICHORACEARUM, D.C. On *Senecio brachyglossus*, F. v M. Stephens Creek, near Broken Hill, Aug., 1918, T G B O (Not listed by MacAlpine.)

OIDIUM sp. On cultivated perennial *Aster*. Blackwood, May, 1919, W Summers No perithecia present, but probably referable either to *E cichoracearum* or to *E. polygoni*.

ERYSIPHE GRAMINIS, D C. On *Bromus mollis*, L. Park Lands, Adelaide, Dec, 1923, G. S. (McAlp., 1895, No 1724)

ERYSIPHE POLYGONI, D C. On cultivated *Delphinium* sp. Aldgate, Feb, 1924, C. H. Beaumont. (Not listed by MacAlpine)

PLEOSPORA HERBARUM, (Pers.) Rab On dead portion of orange leaf, Pinnaroo, Nov., 1923, G. S. Associated with a *Macrosporium* and a *Cladosporium*. The effect on the leaf resembled that described for *Pleospora disruptum*, McAlp. Possibly *P. herbarum* established itself on the dead tissue as a saprophyte, and prevented the fruiting of *Pleospora disruptum*. A very common saprophyte, though not yet "recorded" for South Australia (McAlp., 1895, No. 1701)

FUNGI IMPERFECTI.

BOTRYTIS CINEREA, Pers. On *Gomphocarpus arborescens*, R. Br. Causing death of tips of young shoots. Chambers Gully, Aug., 1922, G. S On cultivated *Crocus* sp. Causing elongated discoloured spots on the leaves. Ambleside, June, 1924, G S (McAlp., 1895, No. 1927.)

HETEROSPORIUM GRACILE, (Wallr.) Sacc. Causing spots on the leaves of *Iris germanica*, L Fullarton, April, 1924, G. S. (Not listed by MacAlpine, but probably wherever *Iris* is grown.)

MACROPHOMA OLEAE, (D.C.) Berl. and Vogl. Common on fallen leaves of *Olea europea*, L., var. *sativa*, D.C. Blackwood, June, 1924, G.S. (Not listed by MacAlpine.)

SEPTORIA APII, Chest. On leaves of *Apium prostratum*, Labill. Noarlunga, May, 1924, G. S. (Not listed by MacAlpine.)

SEPTORIA URTICAE, Desm. and Rob. On *Urtica urens*, L. Horrocks Pass, near Port Augusta, Aug., 1922, G. S. Causing so severe a leaf-spot over a large patch of nettles that the damage was visible at a distance of some yards. (Not listed by MacAlpine.)

PHYCOMYCETES.

CYSTOPUS CANDIDUS, Lev. (syn. *Albugo candida,* (Pers.) Rouss.). On *Blennodia canescens,* R. Br. Curnamona, Aug., 1923, T. G. B. O. This is an exceedingly common fungus on Crucifers, but its presence on a native plant in the arid Far North of South Australia, a district with an average rainfall of about 7 inches, is interesting to note. There had only been 4 inches of rain in the two years previous to its collection. (McAlp., 1895, No. 2198.)

PERONOSPORA PARASITICA, (Pers.) de B. On *Brassica napus,* L. Cottonville, Feb., 1924, per G. Quinn. This is a very common parasite of cabbage seedlings, and has probably existed here for years, though not yet recorded for this State. (Not listed by McAlp., 1895, but recorded for Victoria in 1901 Bulletin, Cabbage and Cauliflower Diseases.)

SYNCHYTRIUM PAPILLATUM, Farl. On *Erodium cygnorum,* Nees. Koonamore, Aug., 1923, T. G. B. O. (Not listed by MacAlpine, but Mr. C. C. Brittlebank informs us that it has been collected on *Erodium moschatum* in Victoria.)

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DESCRIPTION OF PLATES XXI. AND XXII.

PLATE XXI.

Fig. 1. *Uromyces atriplicis,* McAlp. Aecidia covering the under surfaces of the leaves of *Atriplex vesicarium,* Haw. A few teleutosori present.

Fig. 2. *Uromyces phyllodiorum,* (B. and Br.) McAlp Uredosori surrounding spermogonia on tubercular distorted patches on phyllodes of *Acacia penninervis,* Sieber.

Fig. 3. *Uromyces vesiculosus,* Wint. Aecidia on stem bases, and uredosori on leaves of seedlings of *Zygophyllum ovatum,* Ewart.

PLATE XXII.

Fig. 1. *Uromycladium tepperianum,* (Sacc.) McAlp. Galls killing twigs of *Acacia aneura,* F. v. M.

Fig. 2. *Uromycladium tepperianum,* (Sacc.) McAlp. Fusiform galls on stems of *Acacia ligulata,* A. Cunn.

Fig. 3. *Uromycladium tepperianum,* (Sacc.) McAlp. Small witches' broom on *Acacia tetragonophylla,* F. v. M. Sori erupment along smaller twigs.

CHALCIDOIDEA AND PROCTOTRUPOIDEA FROM LORD HOWE AND NORFOLK ISLANDS, WITH DESCRIPTIONS OF NEW GENERA AND SPECIES.

By Alan P. Dodd.

[Read April 10, 1924.]

Through the kindness of the South Australian Museum, the writer has had the opportunity of examining Micro-Hymenoptera collected on Lord Howe and Norfolk Islands by the Museum Entomologist, Mr. A. M. Lea.

The fauna of more or less isolated islands is always interesting, and the present collection bears out this generalisation. The Chalcidoidea show very close relationship to Australian forms, and mainland species are represented; it is rather interesting to find the striking *Metapelma westwoodi*, Girault, in the collection. The occurrence of such peculiar genera as *Cratomus*, Dalman, *Aplatygerrhus*, Girault, and *Hetreulophus*, Girault, calls for remark. The Proctotrupoidea, however, are, on the whole, widely separated from Australian relations; the prevalence of wingless or aborted-winged forms is a typically insular characteristic. *Pseudoceraphron* is a noteworthy discovery, and the species of *Baryconus*, Foerster, and *Hadronotus*, Foerster, are of particular interest.

Superfamily CHALCIDOIDEA.

Family CHALCIDIDAE.

Chalcis, Fabr.

The collection contains one male of a species near *C. victoria*, Girault, and *C. atrata*, Kirby, labelled "Norfolk Island, A. M. Lea."

Stomatoceras, Kirby.

There are two females labelled "Lord Howe Island, A. M. Lea," representing different species and closely allied to the many described forms from Australia. Both are black, the antennae wholly black; one has the legs (except the coxae) red, with a conspicuous black blotch at apical half of posterior femora centrally; the other has the abdomen at its basal half beneath rufous, the legs wholly dark, except the knees and tarsi.

Family AGAONIDAE.

Agaon, Dalman.

A very large series of females; one male, labelled "Reared from Banyan figs, Lord Howe Island, A. M. Lea," would appear to belong here.

Family CALLIMOMIDAE.

Subfamily Idarninae.

Sycoryctes, Mayr.

There is a large series of females, labelled "Reared from Banyan figs, Lord Howe Island, A. M. Lea." I am not aware which *Ficus* is inferred, presumably an introduced tree.(1) Hence it seems safer not to describe the insect, which is wholly metallic-green, the legs wholly yellow.

(1) *Ficus columnaris*. F. v. M. (A. M. Lea).

TRICHAULUS, Mayr.

Two females, yellow, with dusky-barred abdomens, labelled "Reared from Banyan figs, Lord Howe Island, A. M. Lea," can only be referred to this genus.

Family CLEONYMIDAE.

APLATYGERRHUS, Girault.

This genus was erected to contain a single Tasmanian species, with a peculiar antennal structure. The following species are certainly congeneric, and one resembles the genotype, *A. magnificus*, Girault. I have also three or four undescribed forms from Queensland.

Aplatygerrhus imperialis, n. sp.

♀. Rather dark metallic-green, the head, pronotum, and mesonotum with purple reflections; antennae yellow-brown, the apical joint black; legs yellow-brown, the tarsi paler, the posterior coxae metallic

Head densely, rather finely reticulate, and with a sparse pubescence; eyes large, pubescent; lateral ocelli one-half closer to the eyes than to the median ocellus; vertex moderately broad and long; viewed from in front the head is much wider than deep; antennal scrobes obsolete; a faint depression above antennal insertion. Antennae inserted much below ventral ends of eyes and well separated, 11-jointed, the club solid; scape rather short; pedicel somewhat longer than its greatest width, and longer than funicle 2; funicle somewhat incrassate; joint 1 very small, transverse, like a ring-joint; 2 much larger but somewhat wider than long, the remainder gradually increasing in size, but all somewhat wider than long; apical funicle joint with a long lateral extension, or spinous process, that embraces the conical club. Thorax normal; sculpture coarser than that of the head and thus closely reticulate-punctate, the whitish pubescence denser; pronotum rather short; parapsidal furrows about half complete from anteriorly; scutellum simple, longer than wide; axillae rather well separated; propodeum smooth, shining, rather long, narrowed posteriorly, with a complete median carina, at base with a short foveate area that is produced at meson for a short distance on either side of the median carina. Forewings ample, normal; hyaline, marked with brown as follows: a cross-dash at rather more than half-way from base to the marginal vein; a rounded blotch just beneath base of marginal vein; a triangular area involving the stigmal vein, its base resting on the anterior costa, its distal margin straight, its apex half-way across wing and connected with a narrow extension of a long narrow stripe along posterior margin, this latter also connected with a rather narrow stripe along the distal margin of the wing; venation dusky; marginal vein rather long, not much shorter than the submarginal; stigmal vein very long and oblique, fully half as long as the marginal, the postmarginal one-half longer than the stigmal. Abdomen no longer than the head and thorax united; depressed above, gently convex beneath; with a very short petiole; segment 2 (first body segment) about as long as 4; 3 very short, transverse; 5 somewhat longer than 4; 6 plainly longer than 5; 7 hardly as long as 5; 8 shorter than 4; 2 and 3 smooth and polished, also posterior half of 4 and 5; 6 and 7, and basal half of 4 and 5, with open scaly sculpture; 2, 4, and 5 with a tuft of white hairs on either side laterally; 6-8 with scattered pubescence. Legs normal; posterior coxae moderately long; anterior and posterior femora feebly swollen, unarmed. Length, 3·50 mm.

One female, labelled "Norfolk Island, A. M. Lea." Type, I. 14545, South Australian Museum, a female on a card.

The wing pattern is very distinct from that of the genotype.

Aplatygerrhus regalis, n. sp.

♀. Dark metallic-green with purplish reflections; antennae yellow-brown, the scape yellow, the club black; legs very pale yellow (almost white), the posterior coxae metallic for two-thirds of their upper surface.

In general structure agreeing with *A. imperialis*. Head closely, densely reticulate, with a punctate tendency. Antennae inserted very slightly below ventral ends of eyes; scape moderately long; pedicel somewhat longer than funicle 2, which is somewhat wider than long; all funicle joints somewhat wider than long, 1 small but not very transverse. Sculpture and pubescence of thorax as in *A. imperialis*, the sculpture of the scutellum not noticeably finer than that of the scutum; propodeum shining, but with faint surface sculpture, broader, and not as long as in *A. imperialis*; in both species there is a foveate sulcus running straight from the spiracle to the posterior margin and along the latter obliquely almost to the median carina, and laterad of the spiracle is a patch of white pubescence. Forewings lightly stained, hyaline beyond the stigmal vein; there is a large pyramidal, smoky-brown cross-stripe appended from the distal half of the stigmal vein, its apex proximad and produced, its distal margin straight. Abdomen a little longer than head and thorax united; apparently sessile; segment 2 as long as 4, 3 very short, 5 twice as long as 4, 6 hardly longer than 5, 7 distinctly shorter than 5, 8 short; 2 and 3, less than posterior half of 4, and posterior margin of 5, smooth and shining; rest of 4 and 5 and 6 (except posterior margin) densely reticulate with a punctate tendency; 7, 8, and posterior margin of 6, with faint sculpture and white pubescence. Posterior coxae with punctate reticulation; posterior femora rather more swollen than in *A. imperialis*. Length, 5·5 mm.

One female, labelled "On *Kentia canterburyana*, Mt. Ledgbird, Lord Howe Island, A. M. Lea." Type, I. 14546, South Australian Museum, the above female on a card.

This species resembles *A. magnificus*, Girault, with cotypes of which it has been compared, in the unifasciate wing, but there are several important differences; *A. magnificus* has dark antennae, deep-coloured legs, the sculpture of the scutellum is very much finer than that of the scutum, and segment 3 of the abdomen is not much shorter than 4, while 6 is much longer than 5.

Family ENCYRTIDAE.

Tribe EUPELMINI.

EUPELMUS, Dalman.

Two specimens, labelled "Lord Howe Island, A. M. Lea"; the species is metallic-green, the legs partly metallic, the wings hyaline, the ovipositor valves not exserted, and falls in with *E. mawsoni*, Girault, *E. lambi*, Girault, and *E. worcesteri*, Girault.

ANASTATUS, Motschulsky.

One female, labelled "Lord Howe Island, A. M. Lea"; this is a species in which the ovipositor valves are very long. I have the same, or a very similar form, from North Queensland.

METAPELMA WESTWOODI, Girault. Mem. Q'd Mus., iv., 1915, p. 28.

One female, labelled "Lord Howe Island, A. M. Lea." This insect was originally described from Tweed Heads, New South Wales, and the author has a very long series from North Queensland; evidently it is a widely distributed species.

Tribe APHELININI.

APHELINUS, Dalman.

One specimen, labelled "Norfolk Island. A. M. Lea," is black, the abdomen partially yellow, the antennae and legs wholly yellow, and is closely related to *A. dies*, Girault, *A. pax*, Girault, and *A. nox*, Girault, among the many Australian species.

Tribe ECTROMINI.

ANUSIA, Foerster.

The following species falls both in Ashmead's (1904) and Girault's (1915) tables of genera near *Anusia*, and is placed in that segregate for lack of a more suitable position. The multiple genera of the Encyrtidae have been founded very often on such trivial characters, many of which are highly variable, that no one now appears to have a thorough, or even medium, knowledge of their validity.

Anusia viridiflava, n. sp.

♀. Dull orange, washed in places lightly with metallic, the scutum and scutellum either concolorous or mostly metallic; abdomen dusky; meso- and metapleurae fuscous; vertex and upper face bright orange; antennae black, the scape suffused with brown; coxae fuscous, the legs yellow-brown, the femora and tibiae lightly dusky.

Head normal; vertex rather long, from dorsal aspect no more than twice as wide as long, the space between the eyes narrow; frons gently convex; viewed from in front the head is subcircular; eyes large, bare, converging above; ocelli small, the lateral pair close to the eyes, and somewhat closer to each other than to the frontal ocellus; surface densely, finely coriaceous, with a very few, fine, white hairs; mandibles not large, feebly bidentate, the inner tooth broadly truncate. Antennae inserted a little above the clypeus, the scrobes subcircular; scape long, compressed and dilated for its entire length, rather more than twice as long as its greatest width; pedicel normal, somewhat longer than its greatest width; ring joint apparently absent; flagellum subcompressed, subclavate, densely pubescent; funicle joints all much wider than long, plainly shorter than the pedicel; club two-thirds as long as the funicle, obliquely sharply truncate on one margin, the divisions oblique, indistinct. Thorax normal, impunctate, finely shagreened or coriaceous, with a few, fine, scattered hairs; pronotum short, transverse; scutum twice as wide as long; axillae triangular, just meeting at base of scutellum; scutellum sub-triangular, as long as its greatest width; propodeum short, transverse. Forewings somewhat abbreviated, just attaining apex of abdomen; deeply embrowned, the base paler; discal cilia coarse and dense, the marginal cilia very short; venation thick and distinct; submarginal vein joining the costa at almost half-wing length, the marginal vein linear, fully as long as the stigmal, which is almost horizontal and close to the wing margin, the postmarginal hardly developed; an incomplete, oblique, hairless line is present. Legs normal; intermediate tibial spur short and stout. Abdomen short, depressed, triangular. Length, 0·90 mm.

Described from one female, labelled "Norfolk Island, A. M. Lea" (type), and "reared from wood, Lord Howe Island, A. M. Lea" (cotype). Type, I. 14551, South Australian Museum, a female on a card.

In the type, the scutellum is wholly metallic, the scutum washed with metallic; in the cotype, the scutellum is orange, the scutum lightly washed with metallic.

Family PERILAMPIDAE.

Austroperilampus, n. gen.

♀. Head, viewed from above, transverse, broad, the occiput declivous and straight; viewed from the side, the outline of the frons is almost straight; viewed from in front, the head is wider than long, quadrangular, the clypeus broadly truncate; eyes moderately large, bare; ocelli large, the lateral pair closer to the median one than to the eyes; antennal scrobes rather deep, distinct; mandibles very large, broad, deeply bidentate. Antennae inserted in the middle of the face, and slightly above a line drawn across ventral ends of eyes; 13-jointed, with one large ring joint, the club 3-jointed; funicle joints very slightly increasing in width, all a little wider than long; club not enlarged. Thorax stout, from lateral aspect its dorsal outline convex; pronotum large, not as long as the scutum and much wider than long; scutum large, the parapsidal furrows very deep, complete, coarsely foveate; posterior line of scutum not foveate; axillae large, meeting at inner angles, separated from the scutellum by a coarsely foveate groove; scutellum large, convex, no longer than its greatest width, its posterior margin foveate; postscutellum short, raised at meson, sulcate for the rest; propodeum broad, conspicuous, but much shorter than the scutellum, coarsely sculptured, at meson with a median carina that branches at half its length; spiracle prominent, the spiracular sulci represented by a line of foveae. Forewings very large and broad; naked beneath the submarginal vein (*i.e.*, for almost half), the apical half with fine, rather sparse discal cilia; submarginal vein distant from the costa which it joins at almost half-wing length, several times as long as the linear marginal vein; stigmal vein long, two-thirds as long as the marginal, its apex foot-shaped; postmarginal vein hardly developed. Hindwings large, with a long costal vein. Femora bearing long fine setae; tibiae and tarsi densely setose or spiny; posterior coxae long, almost as long as their femora, which are rather stout, their tibiae and tarsi slender, the tibiae with two unequal apical spurs. Abdomen short and stout, not more than one-half longer than its greatest width; sessile; rising abruptly from base; segment 2 (first body segment) longest, occupying one-third of surface; 5 next longest; 3 shorter than 4; 7 very short and abruptly truncate, the ovipositor valves not exserted. Sculpture of body smooth to finely lineolate, with a few punctures.

This genus belongs in that anomalous group of Perilampine genera, which would appear to have their headquarters in Australia, and which are apparently all true gall-makers. In Girault's table of genera (1915) it runs to *Perilampus*, Latrielle, but is not at all related to that genus. It appears closely related to *Trichilogaster*, Mayr., but differs in the non-development of the postmarginal vein, and in having but one ring joint. Genotype, *A. leai*, described herewith.

Austroperilampus leai, n. sp.

♀. Head orange-yellow, a line across the ocelli, and the occiput more or less dusky, eyes and ocelli black; thorax black, a large patch involving almost all of pronotum laterally, and a narrow line across its posterior margin, tegulae, and meson of postscutellum, yellow; abdomen black, brownish-yellow ventrad, also all of second segment; antennae black, the scape and pedicel yellow; coxae fuscous, femora dusky-brown except at base and apex, the legs otherwise clear yellow; mandibles black.

Vertex of head finely transversely striate or lineolate behind the ocelli, and continued laterally for some distance behind the eyes; in front of ocelli longitudinally lineolate or finely striate on either side of antennal scrobes; lower face and cheeks smooth, except for a few, soft, long hairs above the mouth.

Pronotum finely transversely lineolate, smooth posteriorly, with scattered, long, fine, whitish setae; scutum smooth, against and inside the parapsidal furrows with a row of obscure punctures bearing long setae, the surface with a very few, setigerous, small punctures, and showing very faintly, subobsoletely lineolate, this sculpture more distinct anteriorly on the parapsides and adjacent area of the median lobe; axillae smooth, also the scutellum, except for a few, small, setigerous punctures laterally; propodeum inside the spiracle with numerous irregular carinae, outside the spiracle densely rugo-punctate; mesopleurae strongly longitudinally (anterior-posteriorly) striate or lineolate; metapleurae coarsely rugo-punctate. Wings hyaline, the forewings with an obscure brown cross-stripe beneath the end of the submarginal vein; venation conspicuous, yellow-brown. Abdomen smooth and shining, the apical segments finely transversely striate. Length, 3·5 mm.

Two females, labelled "Lord Howe Island, A. M Lea" Type, I. 14552, South Australian Museum, a female, card mounted.

Family MISCOGASTERIDAE.

Tribe LELAPINI.

Lelaps truncatipennis, n. sp.

♀. Dull black; prothorax and adjacent margin of the scutum, posterior portion of the scutellum, axillae, neck of propodeum, petiole of abdomen, and a broad obscure band at half length of the abdomen, deep dull red; face showing reddish; antennae fuscous, the scape yellow, the pedicel suffused yellow, the apical two club joints yellow; coxae pale yellow or whitish, the femora brown, the tibiae deep yellow, the tarsi paler.

Head broad, the vertex rather thin, the occiput straight and immargined; viewed from in front as wide as deep, the frons depressed for its entire length; surface with fine scaly sculpture, which is coarser on the vertex; eyes large, bare; ocelli close together; vertex with six long black bristles, of which two are behind the ocelli and two are on either side against the eyes; at least one mandible tridentate. Antennae inserted below middle of face and slightly above a line drawn across ventral end of eyes; with seven funicle joints and a 3-jointed club (a narrow ring joint may be present, but this was not determined); scape long and slender; pedicel slender, twice as long as its greatest width; funicle 1 somewhat shorter than the pedicel and somewhat longer than wide, 7 plainly wider than long; club longer than the two preceding joints united, conical, its joints 1 and 2 of equal length. Thorax normal; pronotum short, with two black bristles at meson, and one at either latero-posterior angle; scutum with a scaly surface sculpture and recumbent pale pubescence, smooth and polished posteriorly (except laterally), the parapsidal furrows four-fifths complete from anterior margin and well separated; a single black bristle is situated against and inside of each parapsidal furrow at half its length; axillae widely separated; scutellum with a finely foveate transverse groove just beyond the middle, in front of the groove with fine surface sculpture and pubescence, smooth for the rest, with a single black bristle on either side of meson just out from base, and one on either side laterally against and proximad of the transverse groove; propodeum rather long, with a short neck, with complete median and lateral carinae, and with a complete cross-carina at about half its length; mesopleurae large, swollen, smooth, and shining. Forewings abnormal, narrow; very short, extending not far beyond base of abdomen; abruptly truncate at apex; suffused brownish, the infuscation not uniform; discal cilia present on less than distal third; with a costal vein, and no others; arising from the vein are twelve or more stiff black setae or bristles. Abdomen with a short, transverse, rugose

petiole; body of abdomen faintly convex above, deeply convex beneath; no longer than the head and thorax united, pointed conic-ovate; segment 2 (first body segment) occupying slightly more than one-half of surface, 3-6 short, transverse, 7 or apical segment as long as 3-6 combined, the ovipositAl valves slightly exserted; abdomen smooth and shining, with fine scattered setae on segment 7. Legs normal, the posterior tibiae with two very short apical spurs. Length, 3 mm.

Described from one female, labelled "Norfolk Island, A. M. Lea." Type, I. 14553, South Australian Museum.

Neapterolelaps leai, n. sp.

♀. Orange-yellow, the posterior fourth or more of the scutum jet black, the abdomen with two, broad, dusky cross-stripes on its posterior half; legs, including the coxae, pale silvery-yellow, the tibiae and tarsi faintly dusky, the posterior femora dusky, their tibiae pale; antennal scape yellow, the pedicel dusky, the flagellum black (both antennae are incomplete); eyes and ocelli black.

Head normal; vertex moderately long, the occipital margin straight; viewed from in front circular; antennal scrobes extending half-way to median ocellus; surface with fine, close, scaly sculpture and no pubescence; eyes large, reaching to the occiput and extending for two-thirds length of face, bare; ocelli wide apart, in a sub-equilateral triangle, the lateral pair separated from the eyes by somewhat more than their own diameter. Antennae inserted on a level with ventral ends of sides; scape moderately long and slender; pedicel slender, more than twice as long as its greatest width; ring joint small but distinct; funicle 1 somewhat shorter than the pedicel, 4 quadrate (the remaining joints of the antennae are missing). Thorax normal; pronotum rather short, finely alutaceous, and with recumbent pubescence like the scutum; scutum as long as its greatest width, its posterior margin gently convex, the black posterior portion (a fourth or more) without pubescence, finely transversely lineolate and contrasting with the anterior three-fourths; anterior margin of the scutum with a row of fine, erect, black setae; parapsidal furrows forming a Y, three-fourths complete from anteriorly and just attaining the black portion of the scutum, subjoined and sharply curved for their posterior third; axillae rather small, slightly advanced, almost meeting medially; scutellum semicircular, twice as wide as its greatest length, almost smooth, on either side posteriorly with a short erect bristle; propodeum not very long, without carinae, finely irregularly longitudinally rugose. Wings aborted, reduced to short flaps which terminate in a long black bristle. Abdomen no longer than the head and thorax united; pointed conic-ovate; straight beneath, gently convex above; with a very short, stout, transverse petiole; segment 2 occupying a little more than half of surface, smooth but with sparse recumbent pubescence, 3-6 short and transverse, 7 (apical segment) conical and as long as the three preceding segments united, the ovipositAl valves hardly exserted. Posterior femora plainly swollen; posterior tibiae with two long apical spurs, one of which is exceedingly long, as long as the basal two tarsal joints. Length, 3·25 mm.

Described from one female, labelled "Lord Howe Island, A. M. Lea." Type, I. 14554, South Australian Museum.

This species appears to agree with *Neapterolelaps*, Girault, of which only the genotype, *N. lodgei*, Girault, from Queensland, was formerly known; however, Girault's description gives the parapsidal furrows absent; the non-carinate propodeum, aborted wings, and long posterior tibial spurs are distinguishing characters for the genus.

Family PTEROMALIDAE.

Tribe ASAPHINI.

Ophelosia leai, n. sp.

♀. Dull metallic-green, the pronotum washed with brown, the propodeum, sides, and venter of thorax very dark reddish-brown lightly washed with metallic (there is no trace of metallic colouring on the propodeum); abdomen washed with brown; legs wholly dusky yellow-brown, the tarsi clear yellow; antennae fuscous, the scape yellow.

Head transverse, somewhat wider than the thorax, the occiput margined; viewed from in front much wider than deep, the lower half of the face circularly depressed; frons broad; vertex and upper frons finely transversely lineolate, and with a few very fine setae; eyes large, bare; ocelli wide apart, the lateral pair twice as far from the median ocellus as from the eyes; mandibles tridentate, the teeth acute. Antennae inserted against the mouth; 8-jointed, the funicle 5-jointed, the club solid; scape slender, moderately short, as long as the next five joints combined; pedicel not much longer than its greatest width; funicle 1 small, transverse, like a ring joint, 2-5 slightly clavate, all distinctly wider than long; club solid, broadly rounded at apex, as long as the three preceding joints united. Pronotum stout, transverse, finely transversely lineolate and with fine scattered pubescence like the scutum; scutum transverse, twice as wide as long, the parapsidal furrows well marked and complete; axillae widely separated, almost smooth; scutellum longer than its greatest width, with fine sub-transverse impressed reticulation, abruptly smooth posteriorly but without a cross-suture, with a long seta at each anterior-lateral and posterior-lateral angles; propodeum long, somewhat produced, finely irregularly rugose, at base with a pair of fine median carinae that diverge in the form of a V. Forewings moderately long and broad; hyaline, but there is a linear fuscous cross-stripe at the bend of the submarginal vein, involving a number of stiff black discal cilia or bristles, and a large quadrangular blotch appended from the stigmal vein and narrowed at its base; proximal fourth of wing (as far as the cross-stripe) naked, and there is also a naked oblique area beneath all of the marginal vein with its base resting on the first cross-stripe, the remainder of the wing densely finely ciliate; venation yellow-brown, bearing stiff bristles; marginal vein rather more than twice as long as the submarginal, more than twice as long as the stigmal vein, which is long and slender, the postmarginal vein hardly as long as the stigmal. Petiole of abdomen short and stout, appended beneath the extremity of the propodeum; abdomen flat above, faintly convex beneath; smooth; on either side of the base is soft whitish pubescence; basal segment occupying three-fourths of surface. Legs normal; anterior and posterior femora gently swollen; posterior tibial spur long and slender, not much shorter than the basal tarsal joint. Length, 1·5 mm.

Described from two females, labelled "Lord Howe Island, A. M. Lea," and one female, labelled "Norfolk Island." Type, I. 14555, South Australian Museum.

Of the various species of the genus, *O. viridithorax*, Girault, is the only one with much metallic on the thorax, but the original description of that species is too short for the necessary comparison to be made.

TOMOCERA CALIFORNICA, Howard.

There are two females, labelled "Norfolk Island, A. M. Lea." This common Coccid parasite is widely distributed, occurring in California, Hawaii, and Australia. Girault has described two species, *T. glabriventris* and *T. flaviceps*, the former from various localities in Queensland and New South Wales, the latter

from the Northern Territory; I doubt if *T. flaviceps* is distinct from *T. glabriventris,* which, again, appears identical with *T. californica.* I am not aware what reasons Girault has assigned for transferring the genus to the Cleonymidae; to me it bears a close relationship to *Ophelosia,* and I see no reason for altering its usually recognized position.

Tribe CRATOMINI.

This small tribe, containing only two genera, has not previously been recognised in the Australian fauna, and my knowledge of the group has been obtained from Ashmead's Monograph, where it is treated as a tribe in the Subfamily Sphegigasterinae. In the present collection are two species which, together with four others in my own collection from North Queensland, have caused me great trouble to determine satisfactorily. In general appearance and structure these six species closely resemble the members of the Spalanginae, especially *Spalangia* and *Cerocephala;* the similarity is most marked. In fact, but for the somewhat different shape of the head and the position of insertion of the antennae, one would certainly refer them there; but these two differences prevent that solution to the question of their rightful location However, I have very little doubt but that I have correctly placed them; assuming this to be so, then it seems that the *Cratomini* is much more nearly related to the Spalanginae than to the Sphegigasterinae, and should be treated as a tribe in the former subfamily

One anomality remains to be explained. *These species have two apical spurs on the posterior tibiae.* There can be no doubt on this point. I have examined several sets of tibiae, representing at least three species, and in all, two slender apical spurs were made out. But whether these are single or double is the sole distinguishing factor between the families Pteromalidae and Miscogasteridae, the former possessing one, the latter two such spurs. However, the group of species discussed here has no affinities with any tribe in the Miscogasteridae; it is obviously closely related to the Spalanginae, and to remove it thence on account of this trivial character is not warranted. This distinguishing point between the two families is purely artificial, and, in the writer's opinion, untenable

Cratomus, Dalman.

So that the genus, in the sense understood here, can readily be recognised, the characters of this group of species are given below.

♀ Head subglobose; frons convex, produced more or less between the eyes, and divided by two, deep, sharply-defined, antennal furrows, so as to appear tricornute; vertex broad, long; temples broad; eyes not large; ocelli close together, the lateral pair much nearer the median ocellus than to the eye margins Antennae inserted on a level with ventral ends of eyes and about in middle of face; 9-jointed (counting the club as solid); scape long, somewhat curved for its entire length; pedicel short; no ring joint; flagellum subclavate; club conical, the divisions subobsolete. Thorax long; pronotum prominent, long, as long as wide, somewhat narrower than the scutum; scutum no longer than the pronotum, wider than long, the parapsidal furrows deep, complete, foveate, the lobes convex; scutellum large, somewhat longer than its greatest width, simple; axillae meeting inwardly, separated from the scutellum by a coarsely foveate groove; propodeum rather long, narrowed apically, not declivous, with complete lateral carinae, inside these with a network of interlacing carinae, sometimes showing an obscure median carina. Forewings normal, ample, maculate; discal ciliae absent beneath submarginal vein, the distal three-fifths of wing with scattered cilia; marginal cilia absent on anterior margin and posterior margin for two-thirds its length, the rest with a dense short or long fringe of hairs;

submarginal vein distinct from the costa; the marginal vein long but never as long as the submarginal, several times as long as either the postmarginal or stigmal, which are about subequal, the latter curved; venation with stiff setae for its entire length. Abdominal petiole variable, transverse or slender, but never much longer than the posterior coxae; body of abdomen almost straight above, convex below, blunt posteriorly, the ovipositor valves exserted for a length never more than that of the abdomen; segment 2 (first body segment) as long as 4, longest, the others rather short; apical segment and the ovipositor valves bear a few fine setae of great length, besides ordinary setae. Legs normal; posterior coxae rather long; anterior and posterior femora usually somewhat swollen; posterior tibiae with two slender, unequal, apical spurs; tarsi 5-jointed.

♂. At once differing from the female in having the petiole of the abdomen very long, much longer than the hind coxae, and nearly as long as the short body of the abdomen; segment 2 longest but not greatly longer than 3, the rest gradually decreasing in length. Antennae 11-jointed, scape, pedicel, one large ring joint, seven funicle joints, and an apparently solid club.

All the species have been collected on wood, and are probably parasitic on coleopterous larvae.

Cratomus insularis, n. sp.

♀. Black, the abdominal petiole and the pronotum anteriorly reddish; abdomen faintly suffused brownish; ovipositor valves pale yellow for basal third; legs fuscous, the tarsi yellow, t posterior coxae silvery-white except at base above; antennal scape and ped el black, the flagellum deep red.

Head distinctly produced between the eyes; vertex and upper frons smooth, except for scattered minute punctures bearing short fine setae; finely longitudinally striate on either side of frontal prominence; lower face, with coarser denser striae converging around mouth, and also with larger punctures bearing longer setae; cheeks with moderate-sized punctures. Funicle 1 one-half longer than its greatest width, slightly longer and narrower than the pedicel, the flagellum clavate, funicle 6 thus much wider than long; club as long as preceding three joints combined. Thorax smooth and shining, except for a very few minute punctures, the pronotum somewhat longer than the scutum. Forewings subhyaline, with two fuscous bands, the first and narrower one at the junction of the submarginal and marginal veins, the second and broader (but longer than wide) one with its apical margin touching the apex of the stigmal vein; marginal cilia not long; venation fuscous; marginal vein almost as long as the submarginal. Abdomen smooth, except for faint wrinkles on basal half of segments 5-7; segment 2 with its posterior margin rather sharply incised; exserted portion of ovipositor valves equal to two-thirds length of body of abdomen. Legs rather densely pubescent; posterior and anterior femora a little swollen. Length, 2·75 mm. (excluding ovipositor).

Described from four females, labelled "Rotten wood, Lord Howe Island, A. M. Lea." Type, I. 14557, South Australian Museum, a female on a card. One of the undescribed North Queensland species is very similar to the above.

Cratomus viridinotum, n. sp.

♀. Head yellow-brown, the vertex lightly washed with metallic; thorax laterally and ventrally fuscous, above metallic-green, the pronotum almost wholly yellow, the propodeum fuscous, its apex pale-yellow; abdomen brown-black, its petiole pale yellowish; ovipositor valves fuscous; legs, including the coxae, bright yellow, the posterior coxae whitish; antennae yellow, the apical funicle joint and the club fuscous.

Head viewed from in front subcircular; frons gently convex from eye to eye, the antennal scrobes well defined and separated by a thin sharp carina; vertex and frons smooth, except for scattered minute punctures, the face below the eyes finely longitudinally striate; eyes not large; ocelli close together and not very widely separated from the eyes. Antennae inserted on a level with ventral end of eyes; scape as long as next four joints combined; pedicel not much longer than its greatest width; flagellum subclavate; funicle 1 hardly as long as pedicel, 6 somewhat wider than long; club almost as long as preceding three joints combined, its divisions subobsolete. Thorax normal, smooth and shining, with a few minute punctures, the parapsidal furrows and the groove between the axillae and scutellum finely foveate; pronotum subquadrate, as long as the scutum; propodeum finely, transversely, rugose-carinate, the lateral and median carinae obscure. Forewings hyaline, with a broad pale-fuscous band from apical half of marginal and all of stigmal vein; scattered discal cilia of apical three-fifths of wing very fine; marginal cilia moderately short; submarginal and marginal veins about subequal, the stigmal vein short and curved, the postmarginal somewhat shorter than the stigmal; venation yellowish. Abdominal petiole short and transverse; body of abdomen flat above, convex beneath, the ovipositial valves exserted for a length equal to one-third that of abdomen; segment 2 occupying one-third of surface, somewhat longer than 4, 3 short. Legs normal, the anterior and posterior femora not noticeably swollen. Length, 1·60 mm.

Described from one female, labelled "Lord Howe Island, A. M. Lea." Type, I. 14558, South Australian Museum, a female on a card, appendages on a slide.

A rather slender, delicate species, very different from *C. insularis* in appearance, but very similar in structure. The wings bear a marked resemblance to those of the Spalangine genus *Cerocephala,* Westwood.

Tribe SPHEGIGASTERINI.

Polycystomyia benefica, Dodd.

The collection contains three females, labelled "Norfolk Island, A. M. Lea," which should probably be referred to this species, which has been recorded as a parasite of the bean-fly, *Agromyza phaseoli,* Coq.; one specimen has the posterior coxae metallic, the first two pairs of coxae brown, the legs deep yellow; the other two have all the coxae yellow, the legs lighter yellow.

The genus *Polycystomyia,* Dodd, appears identical with *Pseudosphegigasterus,* Girault, the only distinction being that the antennal club is stated to be solid in the latter, 3-jointed in the former; this hardly seems a valid generic character.

Tribe SPALANGINI.

Cerocephala, Westwood.

Three females, labelled "Lord Howe Island, A. M. Lea," are dull brown and fuscous. The species of the genus are parasitic on *Calandra* and other grain weevils, and are cosmopolitan. There is little doubt but that *Spalangiomorpha,* Girault, is identical with *Cerocephala,* and the type species, *S. fasciatipennis,* Girault, is possibly a well-known, widely-spread insect.

Tribe ROPTROCERINI.

Pseudanogmus fascipennis, Dodd.

Several females of this or a very closely-allied species, labelled "Lord Howe Island, A. M. Lea," and "Norfolk Island, A. M. Lea," are much smaller than the typical form, measuring 1·25 mm., and the sooty blotches on the wing are much less pronounced. The type specimen was collected in North Queensland.

Family EULOPHIDAE.

Tribe OPHELININI.

Sympiesomorpha norfolcensis, n. sp.

♀. Bright metallic-green; legs wholly golden-yellow, but the posterior coxae are almost wholly metallic; antennae black, the basal half of the scape yellow.

Head normal; vertex not thin, with fine scaly sculpture; frons depressed, the antennae inserted wide apart and on a level with the ventral ends of the eyes; eyes normal, feebly pubescent; frons smooth. Antennae 10-jointed, with one ring, four funicle, and three club joints; scape long and slender; pedicel not much longer than its greatest width; funicle loosely jointed, with long scattered hairs; funicle 1 much larger than the pedicel and two-thirds longer than its greatest width, 2-4 subquadrate; club not enlarged, not much longer than its greatest width, joint 1 longer than 2 and 3 combined, 3 minute, with a terminal nipple or short spur. Thorax normal; pronotum transverse but distinct, with raised scaly sculpture and a few long setae, its posterior margin almost smooth; scutum with rather coarse raised reticulation, the parapsides finely scaly, the parapsidal furrows well marked and complete; the median lobe of the scutum bears two long fine setae on either side at posterior half against the parapsidal furrows; there is one such setae on each parapside; axillae well advanced, with faint sculpture; scutellum rather long, with rather coarse scaly sculpture, on either side with a well-marked lateral groove that curves round but does not join at the posterior margin; postscutellum prominent, finely scaly; propodeum moderately long, without a neck, almost smooth, with a fine paired median carina, and distinct spiracular sulci. Forewings long; broad; hyaline; discal ciliation normal, the proximal third of the wing (as far as the marginal vein) naked, but there is a short cross-line of cilia at the bend of the submarginal vein that joins a median line of cilia which is continued to reach the posterior margin at half its length; venation well marked; submarginal vein not distinctly broken, as long as the marginal, which is a little longer than the postmarginal; stigmal vein long, slender, about one-third as long as the marginal. Abdomen normal; pointed conic-ovate. Legs slender; posterior tibiae with two short apical spurs; tarsi 4-jointed. Length, 1·8 mm.

Described from one female, labelled "Norfolk Island, A. M. Lea." Type, I. 14563, South Australian Museum.

This species agrees very well with the generic characters, even to sculpture, of *Alophomorpha*, Girault, which Girault originally described in the Ophelinini, and subsequently transferred to the Eulophini, in which tribe the parapsidal furrows are incomplete. Of the other Australian genera of the Ophelinini, it might fall in *Alophomorphella*, Girault, but at least the species is distinct from mainland forms.

Tribe TETRASTICHINI.

TETRASTICHUS, Haliday.

The collection contains a series of a dark-green species of this genus, *sensulatu*, labelled "Lord Howe Island, A. M. Lea."

Tribe HETREULOPHINI.

Hetreulophus clavicornis, n. sp.

♀. Bright metallic-green and blue, the abdomen darker; coxae concolorous, the femora fuscous, the anterior and intermediate tibiae yellow lightly washed with fuscous, the posterior tibiae fuscous with a white band at half their length, which is as long as the apical fuscous portion, tarsi yellow; antennae wholly dark.

Head normal, transverse, no wider than the thorax, with fine impressed reticulation; viewed from in front plainly wider than deep, the frons broad; mandibles tridentate, the teeth acute. Antennae inserted a little above the mouth, 11-jointed, the club solid; scape broad and compressed, hardly more than twice as long as its greatest width, but as long as the next seven joints combined; pedicel stout, not much longer than its greatest width; funicle 8-jointed, the first four joints minute and transverse, like ring joints, 1-6 clavate, 6-8 subequal, each fully twice as wide as long; club bluntly rounded, as long as the three preceding joints united, and more than one-half as long as the scape; antennal joints bearing stiff hairs. Thorax normal; pronotum short; scutum with raised polygonal reticulation, the parapsidal furrows indicated anteriorly; axillae smooth, well advanced; scutellum shining, but showing faint subobsolete reticulation, with a concave line of fine foveae on either side, and a line of similar foveae just before the apex; postscutellum separated from the scutellum by a fine line, smooth, semicircular, and very conspicuous for the family; propodeum shining, moderately long but without a neck, with a median carina and no others. Forewings long and broad; beneath the submarginal vein hyaline and without discal cilia, except for a narrow, brown, median, longitudinal line following a similar line of discal cilia, and terminating at a narrow brown cross-stripe from the bend of the submarginal vein (these two stripes represent the median and basal veins); remainder of the wing uniformly densely ciliated; lightly embrowned, except for two narrow hyaline splashes forming an interrupted line across the wing from the base of the stigmal vein, and an irregular, convex, narrow stripe across the wing from the apex of the stigmal vein; venation normal; submarginal vein not distinctly broken; marginal vein as long as the submarginal; stigmal vein long and curved, the postmarginal twice as long as the stigmal and fully one-half as long as the marginal. Abdomen slender, upturned at apex, the ovipositat valves exserted for a length equal to one-fifth that of the abdomen. Legs normal, the tarsi 5-jointed. Length, 1·45 mm.

Described from two females, labelled "Lord Howe Island, A. M. Lea." Type, I. 14565, South Australian Museum.

This species agrees very well with Girault's diagnosis of the genus, except for the thickened antennal scape and shorter flagellar joints. Girault described the antennae with one ring and seven funicle joints, but in the species before me, as all the joints bear stiff pubescence, it would hardly be correct to consider any of the minute funicle joints as ring joints. The postscutellum is unusually prominent, and the suture between it and the scutellum very delicate; but there is a distinct groove across the scutellum just before this suture. The genus appears to me to be typically Eulophine, despite the 5-jointed tarsi.

Family MYMARIDAE.

Gonatocerus, Nees.

A single specimen of a small, obscure species, black, the legs and antennae wholly dusky, is labelled "Lord Howe Island, A. M. Lea."

Superfamily PROCTOTRUPOIDEA.

Family CERAPHRONIDAE.

Ceraphron, Jurine.

The collection contains a male, labelled "Norfolk Island, A. M. Lea," and also a female labelled "Mt. Gower, Lord Howe Island, A. M. Lea"; the latter is closely related to *C. flavicoxa*, Dodd, and other Australian species.

Pseudoceraphron, n. sp.

♀. Head, viewed from above, large, transverse, much wider than the thorax, which it encircles as far as the posterior margin of the scutum; vertex moderately long, the occiput margined and concave; viewed from in front, the head is triangular, somewhat wider than deep; eyes large, bare, extending to the occipital margin and half-way to the mouth; ocelli minute, wide apart, the lateral pair closer to the median ocellus than to the eyes; mandibles either bi- or tridentate. Antennae inserted somewhat above the mouth but well below a line drawn across the base of the eyes; 11-jointed; scape moderately short, but more than twice as long as the pedicel, which is about twice as long as its greatest width; flagellar joints 1-7 minute, transverse, gradually enlarging, 8 much larger but twice as wide as long, the large club as long as the preceding eight joints combined, conical, twice as long as its greatest width. Thorax, from lateral aspect, almost hidden by the head; viewed from above, twice as wide as long; pronotum not visible from above; scutum very transverse, several times as wide as long, with complete parapsidal furrows, and a complete median groove; scutellum transverse; median segment very short and transverse. Wings entirely wanting. Abdomen somewhat wider than the thorax, twice as long as the head and thorax united, but hardly more than twice as long as its greatest width; from lateral aspect, gently convex above, so deeply convex beneath as to be nearly as high as long; rounded on the sides and non-carinate; broadly sessile at base; basal segment occupying almost all of surface, but the subpointed apex is composed of several transverse segments. Legs normal; femora and tibiae normally slender, those of anterior pair of legs somewhat swollen; apical spur of anterior tibiae long, curved, simple, tarsi short; posterior tarsi two-thirds as long as their tibiae, their basal joint not twice as long as the second and shorter than the enlarged apical joint.

This is a quite distinct and most interesting genus; it falls near *Conostigmoides*, Dodd (*Eumegaspilus*, Ashmead, 1893, *nec* 1888), but the much shortened thorax with its transverse sclerites, the broadly sessile abdomen, and the very small flagellar joints of the antennae, readily distinguish it. In general appearance the genotype bears a striking resemblance to members of the Scelionid genus *Baeus*, Haliday, which is heightened by the short compact flagellum and the much enlarged apical joint of the antennae. Type, the following species.

Pseudoceraphron pulex, n. sp.

♀. Yellow-brown, the abdomen somewhat dusky; legs wholly yellow; antennal scape, less than apical half of pedicel, and the distal funicle joint silvery-white; rest of pedicel, and the first seven funicle joints, black, the club fuscous; eyes and ocelli black.

Body without pubescence. Head smooth and polished; scutum and scutellum finely, irregularly, transversely lineolate; abdomen smooth but showing fine transverse lineolation. Length, ·9 mm.

Described from one female, labelled "Fallen leaves, Lord Howe Island, A. M. Lea." Type, I. 14569, South Australian Museum.

Family SCELIONIDAE.

TRIMORUS, Foerster.

Two species are represented in the collection; one is of especial interest, in that it is the first wingless form of the genus to be discovered in the Australian region; the second is closely allied to mainland species.

Trimorus norfolcensis, n. sp.

♀. Dull black; legs, including the coxae, golden-yellow; antennal scape and pedicel yellow, the rest black.

Head normal; viewed from above, twice as wide as long, the vertex not thin; viewed from in front, plainly wider than deep; eyes large, with a few short setae; ocelli very small, wide apart, the lateral pair separated from the eyes by twice their own diameter; vertex and frons smooth and polished, with a few scattered fine setae; toward occiput with dense surface sculpture; around mouth with converging striae; frons not depressed, but there is a faint median carina running from antennal insertion for some distance. Antennae normal, 12-jointed; scape moderately long and slender; pedicel one-half longer than its greatest width; funicle 1 slightly longer than pedicel, 2 a little shorter than 1, 3 as wide as long, 4 short; club compact, 6-jointed, the joints transverse. Thorax not much longer than its greatest width; scutum much wider than long, broadly rounded anteriorly, with dense fine surface sculpture and numerous pin-punctures bearing fine setae; parapsidal furrows complete, wide apart; scutellum semicircular, smooth except for scattered, setigerous pin-punctures; postscutellum produced at meson in the form of a stout acute tooth; median segment hidden at meson, its caudo-lateral angles subacute. Wings aborted; short narrow flaps that do not reach beyond the posterior margin of the thorax. Abdomen much wider than the thorax, somewhat narrowed at base, blunt posteriorly; segment 1 very short, transverse; 3 almost as long as wide, somewhat longer than 1 and 2 or 4-6 united; 1 and 2 striate, 3-6 with fine, polygonal, surface sculpture and fine pubescence. Legs slender; posterior tarsi no longer than their tibiae, their basal joint as long as 2-4 united. Length, 1·3 mm.

Described from eleven females, labelled "Rotting leaves, Norfolk Island, A. M. Lea." Type, I. 14570, South Australian Museum.

Trimorus leai, n. sp.

♀. Head and thorax black, the abdomen dark brown, its basal segment bright yellow; antennae black, the scape and pedicel yellow, lightly washed with dusky; legs, including the coxae, yellow, lightly washed with dusky.

Head normal; no wider than the thorax, the vertex thin, the frons broad; viewed from in front, somewhat wider than deep; surface smooth and polished; eyes moderately large, bare; ocelli small, the lateral pair somewhat closer to the median ocellus than to the eyes. Antennae 12-jointed; scape long and slender, as long as next seven joints combined; pedicel one-half longer than its greatest width; funicle 1 as long and as wide as pedicel, 2 a little shorter, 3 as wide as long, 4 wider than long; club compact, 6-jointed, the joints much wider than long. Thorax slightly longer than its greatest width; scutum with numerous fine punctures, the parapsidal furrows wide apart, distinct and complete; scutellum semicircular, smooth except for the foveate posterior margin: postscutellum with a short tooth at meson; median segment short, its caudo-lateral angles toothed. Forewings extending well beyond apex of abdomen; moderately narrow (three and a half times as long as the greatest width), the apex rounded; longest marginal cilia equal to one-fourth greatest wing width; discal cilia coarse and dense; venation fuscous, terminating at half-wing length; marginal vein shorter than the submarginal; stigmal vein short, oblique, knobbed at apex; forewings faintly tinted. Abdomen broadly oval, narrowed at base, rounded posteriorly; wider than the thorax; no longer than its greatest width; segment 1 very short and transverse, 2 short, 3 longer than 1 and 2 or 4-6 united; 1 and most of 2 striate, 3 smooth and polished, 4-6 with

a few fine setae. Legs slender; posterior tarsi no longer than their tibiae, their basal joint equal to 2-4 united. Length, 1·1 mm.

Described from one female, labelled "Norfolk Island, A. M. Lea." Type, I. 14571, South Australian Museum.

Of the Australian species, closest to *T. nigripes*, Dodd, but that species has the antennae wholly concolorous, the legs darker, the scutum closely punctured.

HOPLOGRYON, Ashmead.

A well-represented genus in the Australian fauna. The species described herewith has the abdomen much broader at its base than usual; moreover, no mainland species with aborted wings has yet been discovered.

Hoplogryon howensis, n. sp.

♀. Dark brown or fuscous, the first abdominal segment reddish, the scutum dull red; legs fuscous, suffused somewhat with yellow, the tarsi pallid; antennae fuscous, the scape yellowish, the pedicel less so.

Head normal, slightly wider than the thorax, the vertex thin, the frons broad; viewed from in front, rather wider than deep; with dense, polygonal, surface sculpture, and a few, short, fine setae; around mouth with converging striae; eyes moderately large, bare; ocelli very small, the lateral pair somewhat nearer to the median ocellus than to the eyes. Antennae 12-jointed; scape moderately slender, as long as next four joints combined; pedicel short, a little longer than its greatest width; funicle 1 as wide and almost as long as the pedicel, 2 a little shorter than 1, 3 a little shorter than 2, 4 a little shorter than 3 and somewhat longer than wide; club rather slender, 6-jointed; joint 1 quadrate, 2-5 wider than long. Thorax stout, hardly longer than its greatest width; scutum and scutellum with dense, polygonal, surface sculpture, and very fine pubescence; parapsidal furrows absent; scutellum semicircular; post-scutellum at meson with a very small tooth; median segment very short, its caudo-lateral angles toothed. Forewings represented by mere flaps that hardly reach to base of abdomen. Abdomen broadly oval, not much narrowed at base, broadly rounded posteriorly, somewhat wider than the thorax, rather less than twice as long as its greatest width; segment 1 very short, transverse; 2 much longer than 1; 3 as long as wide, more than twice as long as 2; 4-6 short; 1 and extreme base of 2 striate, the rest with dense, polygonal, surface sculpture and very fine scattered pubescence. Legs slender; posterior tarsi no longer than their tibiae, their basal joint as long as 2-5 united. Length, 1·3 mm.

Described from one female, labelled "Lord Howe Island, A. M. Lea." Type, I. 14572, South Australian Museum.

BARYCONUS, Foerster.

Three species are included in this genus, in its present Australian sense; two are closely related to each other, but differ widely from any of the mainland forms; the third is apparently a modified member of one of the Australian groups.

Baryconus discolor, n. sp.

♀. Head pallid yellow, the frontal depression fuscous, the eyes and ocelli black; scutum pale yellow, dusky around the tegulae, and with an oblong brown patch at meson of anterior half; pronotum and scutellum deeper yellow; tegulae pale; sides and venter of thorax (except the pale mesosternum) dusky black; first abdominal segment yellow, 2 and 3 blackish, the former yellowish at base, the latter with an irregular yellow band across base, 4 and 5 brown, each with

a yellow band across base, 6 yellow; venter of abdomen pallid; legs, including the coxae, pale yellow, the tarsi brownish; antennae yellow-brown, the scape paler; mandibles pale yellow, the teeth black.

Head normal; vertex broad, not twice as wide as long, the occiput concave; from frontal aspect the head is subcircular, as wide as deep; lower half of frons at meson depressed, and with a median carina running from antennal insertion for some distance; surface densely punctured, the punctures of moderate size, and with short fine pubescence; frontal depression smooth; mouth with converging striae; mandibles tridentate, the teeth acute; eyes not large, scarcely longer than their distance from the occiput; ocelli small, wide apart, the lateral pair separated from the eyes by their own diameter. Antennae 12-jointed; scape normal, no longer than next two joints combined; pedicel more than twice as long as its greatest width; funicle 1 a little longer than pedicel, three times as long as its greatest width; 2 three-fifths as long as 1; 3 quadrate; 4 wider than long; club compact, 6-jointed, joints 1-5 much wider than long Thorax scarcely as wide as the head, about twice as long as its greatest width; pronotum visible from its neck to the tegulae; scutum a little wider than long, narrowed anteriorly where it is sharply rounded; parapsidal furrows wanting; scutum and scutellum densely punctate and with fine pubescence like the head; scutellum short, its posterior margin straight; postscutellum and median segment excavated and hidden by the abdominal projection; propleurae depressed; mesopleurae punctate, with an elongate smooth meso-posterior path; metapleurae rugo-punctate. Wings vestigial, very narrow; forewings reaching nearly to apex of second abdominal segment, the discal cilia dense and somewhat coarse, the marginal cilia short; a little tinted; venation fuscous; submarginal vein attaining the costa somewhat beyond half-wing length, the marginal as long as the short, very oblique, stigmal vein, the postmarginal not developed. Abdomen almost twice as long as head and thorax united, spatulate, pointed at apex; segment 1 petioliform, twice as long as wide, 2 and 3 each as long as their greatest width and a little longer than 1, 4 and 5 wider than long and plainly shorter than 2 or 3, 6 somewhat longer than 5 and longer than its basal width; segment 1 with a blunt basal horn that projects into the thorax as far as the scutellum, strongly longitudinally rugo-striate, the apex of the horn smooth; 2 longitudinally striate; 3-6 with dense punctures and fine silvery pubescence, 3 with a smooth mesal path. Legs slender; posterior coxae long, not much shorter than their femora; posterior tibiae slender; basal joint of posterior tarsi very long, a little longer than 2-5 united and three-fifths as long as their tibiae. Length, 4 mm.

♂. Colorationally like the female; differs only in sexual characters, no basal horn of abdomen, the apical abdominal segment short. Antennae yellow-brown, paler at base than toward apex; scape moderately short and stout; pedicel twice as long as its greatest width; flagellar joints cylindrical, 1 longest, two-thirds longer than the pedicel, 9 one-half as long as 1. Forewings perfect, attaining apex of abdomen; broad; stained brownish; venation fuscous; submarginal vein attaining the costa at about half-wing length; marginal vein nearly one-half as long as the stigmal, which is long, oblique, a little convexly curved; postmarginal a little longer than the stigmal; basal vein distinct, somewhat oblique; median vein as an ill-defined thick line beyond the basal vein. Length, 3·5 mm.

Three females, one male, labelled "Lord Howe Island, A. M. Lea." Type, I. 14573, South Australian Museum.

Colorationally and structurally this species differs markedly from any of the known Australian forms.

Baryconus vestigialis, n. sp.

♀. Extremely like *B. discolor*, but differs in colour as follows: Head uniformly yellow-brown (not pale yellow), the frontal depression not black, the mandibles concolorous; thorax of a darker tint; abdomen dark brown or fuscous, the first segment concolorous, the yellow bands of *B. discolor* almost obliterated here. Structurally differs from *B. discolor* as follows The median segment is not hidden by the abdominal projection and is moderately long, covered with very fine pubescence; the horn on the basal abdominal segment does not project forward into the thorax; the abdomen is shorter, one-half longer than the head and thorax united, segment 1 less than twice as long as wide, 6 no longer than its width at base; pubescence denser on segments 3-6, 2 also with some pubescence; wings still narrower and shorter, scarcely reaching beyond base of second abdominal segment, the venation obscure, the stigmal vein seemingly not developed. Length, 3 mm.

Four females, labelled "Mt. Gower and Lord Howe Island, A. M. Lea" Type, I. 14574, South Australian Museum.

The colour varies slightly; in three specimens the posterior coxae and femora are somewhat dusky. A smaller, duller species than *B discolor*; the strikingly similar colour pattern led me at first to regard it as a variety of that species, but the several slight structural differences would seem to denote specific rank; the distinctions are negative rather than positive

Baryconus vestitus, n. sp.

♀. Head black; thorax bright orange or yellow-brown; abdomen fuscous, the third segment yellow for its basal half; legs, including the coxae, bright yellow; antennae fuscous, the scape yellow.

Head normal; vertex rather long, twice as wide as long; from frontal aspect, the head is somewhat wider than deep; vertex and upper frons densely finely punctate and coriaceous, and with scattered short pubescence; lower half, or less, of face, feebly depressed, with a median carina running from antennal insertion, the depression finely transversely alutaceous; cheeks narrow, finely longitudinally alutaceous; mouth with very fine converging striae; eyes large, extending to the occiput, and as far as a line drawn across antennal insertion, bare; ocelli very small, wide apart, the lateral pair against the eyes. Antennae 12-jointed; scape normal, as long as the next four joints combined; pedicel one-third longer than its greatest width; funicle 1 plainly longer than pedicel, fully twice as long as its greatest width, 2 shorter than 1, 3 quadrate, 4 wider than long; club compact, 6-jointed, joints 1-5 transverse, 1 smaller than the others. Thorax not much longer than its greatest width; pronotum hardly visible from above; scutum large, broadly rounded anteriorly, the parapsidal furrows absent; scutellum semicircular; scutum and scutellum finely, very densely coriaceous and punctate, and with rather dense, short, black pubescence; postscutellum hidden; median segment concave, not visible medially, its latero-posterior angles acute; propleurae with fine surface sculpture; meso- and metapleurae punctate, the former with a smooth, elongate, meso-posterior depression. Wings vestigial; short, narrow flaps. Abdomen fusiform; narrowed at base, pointed at apex; one-half longer than the head and thorax united; segment 1 short, fully twice as wide as long, with a rounded prominence or bosse at base; 2 more than twice as long as 1, somewhat shorter than its width at posterior margin; 3 a little longer than 2, scarcely as long as wide; 4 one-half as long as 3, as long as 5 and 6 combined; 1 striate, its prominence reticulate; base of 2 striate; the rest with a very dense, fine, surface sculpture, and very dense clothing of short black setae. Legs normal; posterior tarsi

not as long as their slender tibiae, their basal joint as long as 2-5 united. Length, 2·3 mm.

Described from one female, labelled "Lord Howe Island, A. M. Lea." Type, I. 14575, South Australian Museum.

Although the basal abdominal segment is shorter, its prominence not conspicuous, and the abdomen more fusiform, the affinities of this species are probably with the group of Australian species that contains *B. splendidus*, Dodd, *B. magnificus*, Dodd, *B. superbus*, Dodd, and others.

HADRONOTUS, Foerster.

There is a single male belonging to this genus, and closely related to *H. parvipennis*, Dodd, labelled "Rotting leaves, Norfolk Island, A. M. Lea." The species described herewith is not a true member of the genus, and is placed there for lack of a suitable position.

Hadronotus terrestris, n. sp.

♀. Head black; thorax bright orange or yellow-brown, the meso- and metapleurae darker; abdomen fuscous, with two irregular yellow bands at bases of segments 2 and 3; legs wholly yellow; antennae fuscous, the scape yellow.

Head slightly wider than the thorax, the vertex of normal length; from lateral aspect, vertex and frons gently, regularly convex; occiput not margined; viewed from in front, the head is plainly wider than deep; lower half, or less, of face a little depressed, with a blunt median carina, very finely, circularly striate; mouth with fine converging striae; vertex and upper frons finely, very densely coriaceous; eyes moderately large, extending almost to occipital margin, ocelli minute, very wide apart, the lateral pair against the eyes. Antennae normal, 12-jointed; scape moderately long and slender; pedicel scarcely longer than its greatest width; funicle 1 a little longer than pedicel, 2 quadrate, 3 wider than long, 4 very small, transverse; club compact, 6-jointed, joints 1-5 transverse. Thorax stout, no longer than its greatest width; pronotum not visible from above; scutum large, very broadly rounded anteriorly, the parapsidal furrows absent; scutellum semicircular; scutum and scutellum with fine surface sculpture and fine, dense, black pubescence; postscutellum and median segment not visible, except the latero-posterior angles of the latter, the thorax at meson abruptly terminating at apex of scutellum. Wings vestigial; very short and narrow flaps. Abdomen a little longer than the thorax, and more than twice as long as its greatest width; hardly narrowed at base, pointed at apex; segment 1 broadly sessile, very short and transverse; 2 large; 3 slightly longer than 2, somewhat wider than long, as long as 4-6 united; abdomen wholly clothed with a very dense, fine pubescence, and with microscopic sculpture. Legs slender; posterior tarsi hardly as long as their slender tibiae, their basal joint about as long as 2-5 united. Length, 1·6 mm.

♂. Agreeing in all particulars with the female. Antennae 12-jointed; pedicel small, no longer than wide; funicle 1 twice as long as wide, 2-9 gradually shortening, 9 slightly longer than wide, 10 as long as 1.

Described from nine females, three males, labelled "Fallen leaves, Lord Howe Island, A. M. Lea." Type, I. 14577, South Australian Museum.

The yellow bands on the abdomen vary somewhat in length. One male has the thorax deep chestnut, the abdomen wholly fuscous. This species may well be a wingless form of *Hadronotus*, but the abdomen is longer than is usual in that genus.

TELENOMUS, Haliday.

One male, labelled "Lord Howe Island, A. M. Lea."

Family DIAPRIIDAE.

TETRAMOPRIA, Wasmann. Dodd, Trans. Roy. Soc. S. Austr., 1916.

The species described below agrees with the characters of the two Australian species; the three ought possibly to form a new genus. In Kieffer's table of genera (1911), they run to *Tetramopria*, Wasmann, and *Geodiapria*, Kieffer, but differ from both in lacking a basal fovea to the scutellum.

Tetramopria plana, n. sp.

♀. Dull black; legs, including the coxae, bright yellow; petiole of abdomen reddish; tegulae yellowish; antennae yellow, the three apical joints fuscous.

Head depressed; from dorsal aspect somewhat longer than wide, truncate anteriorly, and irregularly pentagonal in outline, the antennae inserted against anterior margin; eyes small, situated rather far forward, distinctly shorter than their distance from the occiput; ocelli close together, plainly nearer the occiput than the anterior margin; surface smooth and shining. Antennae 12-jointed; scape moderately long and slender; pedicel narrowed at base, three times as long as its greatest width; funicle joints narrower than the pedicel and much shorter; funicle 1 narrowed at base, twice as long as its greatest width, 2-7 gradually shortening, 7 a little longer than wide; club abruptly 3-jointed, the joints longer than wide. Thorax depressed; pronotum very short; scutum and scutellum flat, smooth and shining; parapsidal furrows wanting; scutellum as long as wide, without a median carina or basal foveae; median segment long, as long as the scutellum, finely rugose, with a distinct median and lateral carinae. Forewings extending well beyond apex of abdomen; subhyaline; moderately narrow, the margins equally inclined; marginal cilia very long, the longest equal to more than one-half greatest wing width; discal cilia not very dense; venation yellowish, terminating in a short, thickened, marginal vein at basal third of wing; basal vein absent. Petiole of abdomen slender, more than twice as long as wide, densely pubescent; body of abdomen depressed, twice as long as its greatest width, its base distinctly separated from the petiole, its basal segment fully twice as long as the following united, smooth and shining. Length, 1·75 mm.

♂. Body less depressed than in the female, the head no longer than wide. Antennae 14-jointed; scape and pedicel yellow, the flagellar joints fuscous, their basal stalks yellowish; scape normal; pedicel short and stout; flagellar joints nodiform, long, about subequal, with a pubescence of scattered long hairs.

Described from one female, labelled "Lord Howe Island, A. M. Lea," and one male, labelled "Norfolk Island, A. M. Lea." Type, I. 14579, South Australian Museum.

Differs from the other Australian species in having the female antennal club 3-jointed.

Phaenopria norfolcensis, n. sp.

♀. Head and abdomen black; thorax chestnut-red; legs bright golden-yellow; antennae golden-yellow, the club fuscous.

Head normal, from dorsal aspect as wide as long, from lateral aspect not as long as its height; smooth and polished, with a very few scattered setae; ocelli absent; eyes small, situated anteriorly and somewhat laterally, not as long by much as their distance from the occipital margin. Antennae 12-jointed; scape long and slender; pedicel fully twice as long as its greatest width; funicle joints shorter and somewhat narrower than the pedicel, 1 one-half longer than

wide, 7 wider than long; club abrupt, 3-jointed, joints 1 and 2 somewhat wider than long, 2 wider than 1, 3 conical and one-half longer than wide. Thorax compressed, much narrower than the head or abdomen, over three times as long as its greatest width; scutum and scutellum smooth and shining; scutum longer than its greatest width, without furrows; scutellum somewhat longer than wide, without a trace of basal foveae, its rim pubescent; median segment long, rather longer than the scutellum, with a clothing of long silvery pubescence. Wings entirely wanting. Petiole of abdomen short, no longer than wide, densely pubescent; body of abdomen smooth and shining, two and a half times as long as its greatest width, the basal segment occupying almost all of surface. Length, 1·5-1·75 mm.

♂. Ocelli present, small; thorax rather less compressed; wings present as narrow flaps that reach the posterior margin of the petiole; basal abdominal segment occupying less than three-fourths of surface. Antennae 14-jointed; pedicel twice as long as its greatest width; funicle 1 a little longer than the pedicel; 2 one-half longer than 1, curved and dilated on one margin at apex; 3 as long as 1; 3-12 moniliform, each bearing a few, long, fine setae.

Described from three females, one male, labelled "Rotting leaves, Norfolk Island, A. M. Lea." Type, I. 14580, South Australian Museum, one female.

An allied wingless form, *Loxotropa grandiceps*, Dodd, has been described from New South Wales, which differs at once in having a basal fovea to the scutellum.

SPILOMICRUS, Westwood.

The collection contains one female, labelled "Rotting leaves, Norfolk Island, A M. Lea"; this is very closely allied to *S. gracilis*, Dodd, and may not be distinct. A second species is represented, which belongs to the group of species described by me under the genus *Bothriopria*, and subsequently referred to *Spilomicrus*.

Spilomicrus howensis, n. sp.

♀. Black, the antennae wholly concolorous; legs dull yellow, the coxae and femora brown; tegulae reddish.

Head from dorsal aspect subquadrate, not much wider than long; viewed from the side, higher than long, the frons perpendicular to antennal insertion, which is not conspicuous; surface smooth and shining, with numerous, scattered, long, fine setae; eyes small, not as long as their distance from the occiput. Antennae 13-jointed; scape slender, terminating acutely on either side of base of pedicel; pedicel twice as long as its greatest width; funicle joints plainly narrower and shorter than pedicel, 1 twice as long as wide, 2 slightly longer than wide, 6 slightly widened and as wide as long; club 5-jointed, joint 1 not as wide as 2, 1-4 a little wider than long, the apical joint a little longer than the preceding. Thorax fully twice as long as its greatest width; pronotum with long dense pubescence; scutum rather flat, with a few scattered setae, the parapsidal furrows as distant grooves posteriorly and about one-half complete; scutellum at base with two circular foveae a little separated, the lateral foveae shallow and long, the posterior margin finely foveate; median segment fully as long as the scutellum, feebly pubescent and obscurely rugose, with distinct lateral carinae and an obscure raised tooth at base. Forewings reaching apex of abdomen; moderately broad, the apex sharply rounded; stained brownish; venation terminating at almost half-wing length in a short, thickened, marginal vein, the stigmal vein very short; basal vein well marked. Petiole of abdomen twice as long as wide, tricarinate, its basal half pubescent; body of abdomen well raised from petiole, oval, rounded posteriorly, rather more than twice as long

as its greatest width; smooth and shining; segment 2 occupying three-fourths of surface, the following segments with a few long setae. Length, 2 mm.

Described from two females, labelled respectively "Summit of Mt. Gower, Lord Howe Island, A. M. Lea," and "On *Kentia,* Lord Howe Island, A. M. Lea." Type, I. 14582, South Australian Museum.

Of the Australian species, quite close to *S. aureipes,* Dodd, *S. ater,* Dodd, and *S. infuscipes,* Dodd, but the more quadrate head and small eyes will serve to distinguish it.

Family PLATYGASTERIDAE.

No systematic work has yet been done on this group in Australia; the species must be very numerous, and a few have been described. Ashmead's classification of 1893 has been used as a basis, when referring species to genera

Trichacis howensis, n. sp.

♀. Black, shining; legs, including the coxae, bright golden-yellow; antennal scape yellow, also the first funicle joint, the pedicel fuscous, the antennae otherwise black; mandibles reddish-yellow.

Head normal; vertex thin, transverse, and showing very faint, fine, impressed sculpture; viewed from in front as wide as deep, the frons smooth and shining; antennae inserted just above the mouth, in a circular depression, and separated by a small tubercle; a few, fine, weak hairs are around antennal depression, and there is a scattered row of these same fine hairs against the eyes; mandibles long, slender, bidentate, the teeth acute; eyes moderately large, bare; ocelli wide apart, the lateral ones separated from the eyes by about their own diameter. Antennae 10-jointed; scape long and slender, as long as next five joints combined; pedicel small, hardly longer than its greatest width; funicle 1 minute, cupuliform, no longer than its greatest width, 2 twice as long as wide, and almost twice as long as pedicel, 3 plainly shorter than 2, 4 very small and no longer than wide; club 4-jointed, no wider than the funicle, loosely jointed, the joints much longer than wide, 1 subequal to 4 and slightly longer than 2 or 3, as long as funicle 2. Thorax normal, not twice as long as its greatest width; pronotum smooth and shining, with a very few, fine, weak hairs, the sclerite distinct laterally and dorsally; scutum somewhat narrowed anteriorly, one-half longer than its greatest width, its meson at posterior margin produced into the scutellum for some distance, smooth and shining, a scattered line of white, fine hairs follows the anterior and lateral margins; parapsidal furrows not evident, but a line of fine white hairs marks their course; scutellum small, not distinctly separated from the scutum, raised medially, rather abruptly declivous laterally and posteriorly, covered with a dense, fine, whitish pubescence except at extreme meson; median segment very short; pleurae smooth and shining, the metapleurae with rather dense pubescence. Forewings extending somewhat beyond apex of abdomen; broad, hardly more than twice as long as the greatest width; faintly tinted, except at base; marginal cilia fine, short, and dense; discal cilia almost absent on basal two-thirds of wing, the apical third with about 24 rows of cilia, which are much more dense toward anterior than toward posterior margin; a short submarginal vein is indicated. Petiole of abdomen very short, transverse; body of abdomen no longer than head and thorax combined, two and a half times as long as its greatest width; composed of four segments; segment 2 (first body segment) as long as 3-5 combined, at base with a pubescent fovea on either side of meson, and posterior of each fovea finely striate for some distance, the rest smooth and shining; 3 and 4 subequal, 3 at base with a transverse row of close punctures, 4 with its basal

half punctate; 5 as a conical projection, hardly longer than 4, and almost twice as long as its greatest width. Legs slender, the tarsi 5-jointed. Length, 1 mm.

Described from ten females, labelled "Lord Howe Island, A. M. Lea." Type, I. 14583, South Australian Museum.

Amblyaspis flavibrunneus, n. sp.

♀. Bright brownish-yellow or castaneous, the head, prothorax, and metathorax yellow; eyes and ocelli black; legs golden-yellow, the femora and clavate portion of tibiae suffused with brown; antennae brownish-yellow, the club fuscous.

Head normal; vertex transverse, with very fine impressed reticulation; viewed from in front the head is slightly wider than deep, the frons smooth and not depressed; eyes rather long, extending for almost the length of the frons; ocelli wide apart, the lateral pair a little separated from the eyes. Antennae separated by a small tubercle; 10-jointed; scape almost as long as next five joints combined, very slender, swollen at half its length; pedicel slender, three times as long as its greatest width; funicle joints very slender, narrower than pedicel, 1 two-thirds as long as pedicel; 2 slightly longer than 1, 3 one-half as long as 2, 4 a little shorter than 3; club slender, 4-jointed, joint 1 cupuliform and twice as long as its greatest width, as long as funicle 2, 2 and 3 subequal, barely as long as 1 and not much longer than wide, 4 one-half longer than 3. Thorax normal, twice as long as its greatest width; pronotum prominent anteriorly and laterally, opaque; scutum narrowed anteriorly, somewhat longer than its greatest width, with very fine, dense, impressed reticulation or scaly sculpture, the parapsidal furrows replaced by a complete line (composed of several rows) of fine, dense, pallid pubescence; scutellum raised, covered with fine, dense, pale pubescence, produced posteriorly in a long slender spine high above the median segment for almost its entire length; median segment long, with rather long fine pubescence, rimmed laterally, and with a thick, high, median carina Forewings very long, extending far beyond apex of abdomen; moderately broad, about four times as long as their greatest width; hyaline for less than basal third, the rest somewhat tinted; longest marginal cilia equal to one-fourth wing width; discal cilia excessively dense right up to base of wing; submarginal vein faintly indicated; hindwings very narrow and pointed, hyaline for basal third, their longest marginal cilia equal to the greatest width, the discal cilia exceedingly dense. Petiole of abdomen no longer than wide, pubescent; body of abdomen ovoid, hardly twice as long as its greatest width, broadly rounded posteriorly; smooth; basal segment occupying three-fourths of surface, the others very short. Legs slender; all trochanters very long, as long or longer than their coxae, and half as long as their femora; femora a little swollen in centre; tibiae with a long basal stalk, which in the long posterior pair is almost twice as long as the apical swollen portion; tarsi slender, 5-jointed; posterior tarsi somewhat longer than their tibiae, their basal joint as long as 2-5 combined. Length, 1·3 mm.

Described from two females, labelled "On *Kentia canterburyana,* Mt. Ledgbird, Lord Howe Island, A. M. Lea." Type, I. 14584, South Australian Museum.

Family BETHYLIDAE.

Sclerodermus norfolcensis, n. sp.

♀. Dull black, the abdomen piceous; legs piceous, the tibiae and tarsi testaceous; antennal scape brownish-yellow, also the next two or three joints, the rest of the antennae piceous.

Body completely flattened, from lateral aspect appearing strongly compressed. Head, viewed from above, plainly longer than wide, with dense, polygonal, scaly sculpture; hind margins rounded, the lateral margins parallel, the clypeus truncate; eyes normal, situated far forward, not as long as their distance from the posterior margin of the head; ocelli close together near the posterior margin, the lateral parts separated from each other by less than their own diameter, separated from the frontal ocellus by their own diameter; a fine groove runs from just inside of each antennal insertion, joining medially and continued as an obscure groove for half the length of the head; mandibles dusky, long, straight, tridentate, the teeth acute, the outer longest, the inner one small; maxillary palpi at least 3-jointed. Antennae short, 13-jointed; scape stout, somewhat clavate, as long as the next four joints combined; pedicel one-third longer than its greatest width; funicle 1 plainly shorter than the pedicel, no longer than its greatest width, 3 longest (not including the apical joint), but hardly as long as the pedicel, 4-10 gradually shortening, 10 a little longer than wide, the last joint twice as long as the penultimate. Thorax a little narrower than the head or abdomen, three times as long as its greatest width; with similar polygonal sculpture to that of the head, but on the median segment this is coarser and inclines towards reticulation; pronotum as long as its greatest width, as long as the scutum and scutellum combined, rounded anteriorly; scutum without a trace of furrows, more than twice as wide as long; scutellum without a transverse groove at base, its posterior margin gently convex; median segment distinctly longer than its greatest width, without grooves or carinae, not retracted at base, its posterior angles rounded; tegulae present in both winged and apterous forms. Wings wanting, or fully developed; in the winged form, forewings long, faintly tinted, with no venation except a short submarginal vein that thickens at the apex and touches the costa, forming a closed costal cell. Abdomen not twice as long as its greatest width; pointed ovate; with fine, scaly, surface sculpture. Legs short; all femora very much swollen; tibiae not spined; posterior tibiae with two apical spurs, one short, the other long and slightly curved; tarsal claws simple. Length, 3 mm.

Described from four females, labelled "Rotting leaves, Norfolk Island, A. M. Lea." Type, 14585, South Australian Museum.

Of the four specimens, three are apterous; there appear to be no structural differences between the two forms. The species does not agree with the characters of *Sclerodermus* as given by Kieffer (1908); the wing venation resembles *Cephalanomia*, but that genus has 12-jointed antennae.

Arysepyris citripes, n. sp.

♀. Dull black, the abdomen somewhat piceous; legs, including the coxae, wholly intense lemon-yellow; antennae dull yellow, the basal three or four joints intense yellow.

Head shaped as in *Goniozus* and its allies, its greatest length rather more than its greatest width, narrowed and produced in front of the eyes, the mandibles thus not prominent; surface with fine, impressed, scaly reticulation and a few, scattered, fine setae; eyes about as long as their distance from the occipital margin; ocelli almost equidistant from one another, the lateral (and posterior) pair much closer to the occipital margin than to the median ocellus. Antennae 13-jointed; scape stout, rather less than twice as long as its greatest width; pedicel longer than any of the funicle joints, about twice as long as its greatest width; funicle 1 narrowed at base, one-third longer than its greatest width, slightly the longest joint of the funicle, 2 the shortest and quadrate, 3-10 subequal, moniliform, slightly longer than wide, the apical joint a little longer than

the preceding. Thorax long, rather more than twice as long as its greatest width; pronotum as long as the scutum and scutellum combined, somewhat wider than long; scutum transverse, without furrows; scutellum without a groove or fovea at base; median segment as long as the pronotum, without grooves or carinae, immargined laterally, abruptly declivious posteriorly; thorax with similar sculpture to the head. Wings represented by flaps which attain the base of the median segment. Abdomen pointed conic-ovate. Legs normal; anterior femora much swollen, more so than the posterior pair; all tarsi simple. Length, 1·5 mm.

Described from seven females, labelled "Lord Howe Island, A. M. Lea." Type, I. 14586, South Australian Museum.

SIEROLA, Cameron.

Although very few species have been described, this genus would appear to be particularly well represented in the Australian region. This collection contains a series of specimens, probably representing more than one species, from both Lord Howe and Norfolk Islands.

Family DRYINIDAE.

GONATOPUS, Ljungh.

One female, labelled "Lord Howe Island, A. M. Lea," is referable to this genus, in its wider sense. No attempt was made to dissect out the mouth parts.

ON THE SPECIALISED INCISOR TEETH OF SOME OF THE DIDACTYLOUS MARSUPIALS.

By Frederic Wood Jones, D.Sc., F.Z.S.,

Professor of Anatomy in the University of Adelaide.

[Read August 14, 1924.]

I have suggested elsewhere (Mammals of South Australia, part ii, p 135) that the reason for the development of the syndactylous toilet digits in the diprotodont marsupials is a direct outcome of the dental condition of this section of the didelphia. The marsupials have need of a hair comb, the need probably being the necessity of ridding the fur of the presence of *Mallophaga*, or biting lice, which so commonly infest them. This need is met in the typical polyprotodonts by nibbling the fur with the numerous little sharp front teeth, aided by scratching with the pes When, in response to an altered diet, the nature of

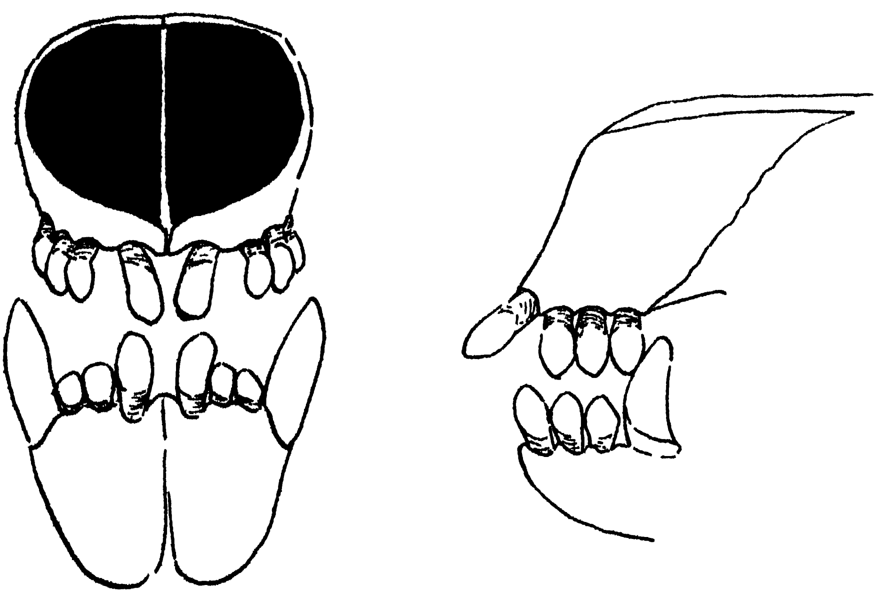


Fig. 1.
The anterior teeth of *Dasycercus cristicauda*. Front and side views.

the dentition is changed and the numerous little pointed front teeth are replaced by the few chisel-shaped incisors, the pedal hair comb becomes more specialised and the syndactylous second and third pedal digits are developed.

Even before the front teeth have become few in number, and at the stage when they have only lost their pointed character, the pedal hair comb is developed. The members of the Peramelidae possess the syndactylous pedal hair comb, despite the fact that their front teeth are numerous. A bandicoot is a polyprotodont, and has five upper and three lower incisors upon each side of its jaws; but the incisors are no longer of the same type as those seen in the rest

of the polyprotodonts, for they have lost their prong-like character and have become chisel-shaped.

That teeth should be used in the toilet of the hair is no surprising thing; everyone must have seen a dog nibble its coat in the effort to dislodge or to capture a flea. I have frequently watched the little carnivorous Pouched Mice *(Dasycercus cristicauda)* engaged upon the toilet of the coat. These attractive little animals scratch themselves vigorously with the digits of the pes; but if any part of their body demands especial attention, they turn their heads and nibble and comb their hair in a very characteristic fashion. From these observations I have been for some time convinced that the front teeth and the syndactylous digits were complementary structures, vicariously discharging the same functions; and have already suggested that the little sharp front teeth of certain animals are probably of more importance as toilet implements than as organs connected with alimentation. It is only of late, however, that, in watching *Dasycercus* at its toilet, I have come to realize that there is a remarkable specialisation of its front teeth which is, as far as I can determine, related solely to the function of hair combing. Of the eight incisors carried in the upper jaw, two, the central members, are in every way abnormal (see fig. 1). These two teeth are remarkable, not only in their form, but in the axis in which they are carried in the jaw, for they rake forward at an angle which carries them out of

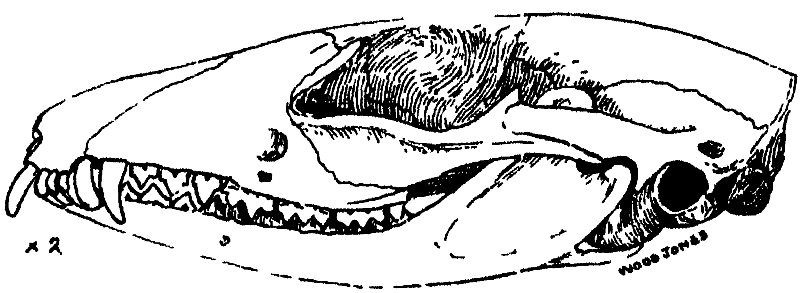


Fig. 2.
Left lateral view of the skull of *Phascogale penicillata*

alignment with all the rest of the teeth. So marked is this projection of the upper central incisors that, in the normal position of the jaws, they do not articulate with the corresponding members of the mandibular series. The upper central incisors are large teeth, larger and longer than their fellows, from which they are separated by an interval which exceeds their own diameter. They are also separated from each other by a slightly smaller interval in the mid line, and at their tips they somewhat tend to approach each other. The corresponding lower central incisors are also specialised, being considerably longer and larger than their fellows, and separated from each other in the mid line by an interval similar to that which separates the incisors of the upper jaw. When the jaws are opened and shut it will be seen that these specialised front teeth do not bite together as the other incisors do, but the lower centrals close behind the upper centrals, their "occlusal" surfaces failing to articulate. It is impossible, after having watched the animal at its toilet, to avoid the conclusion that these specialised, projecting incisors, separated by a median gap, are the functional counterpart of the little parallel claws of the syndactylous pedal digits. Indeed, it is difficult to postulate any other function from them.

Dasycercus is not the only didactylous didelphian exhibiting this specialisation of the anterior teeth, for, with the exception of *Sarcophilus*, all the species which I have been able to examine show the peculiarity in some degree. The

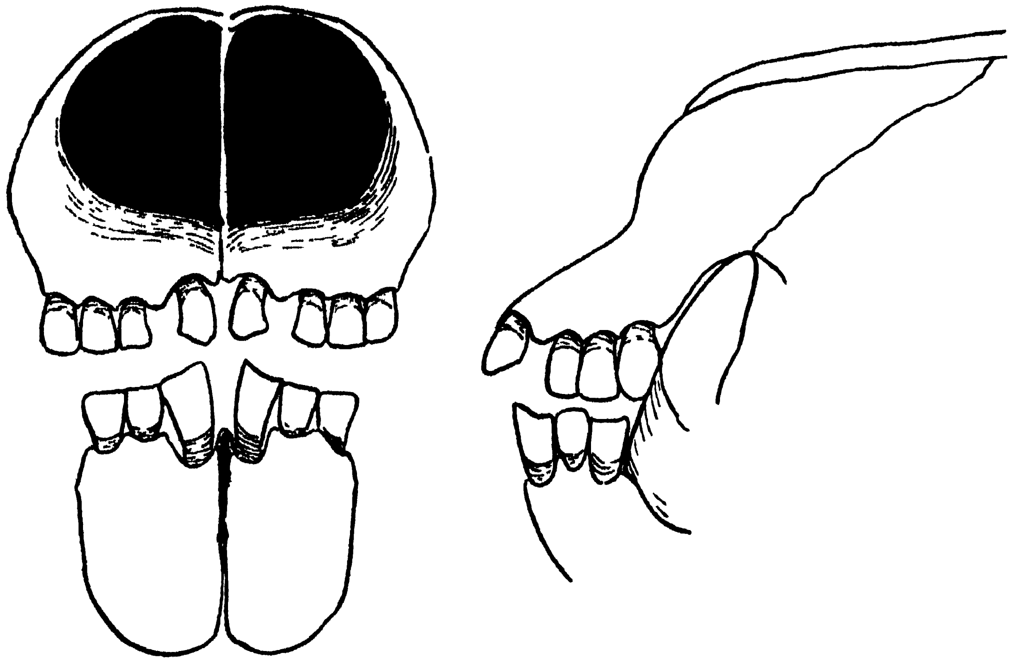


Fig 3
The anterior teeth of *Dasyurus geoffroyi* Front and side views

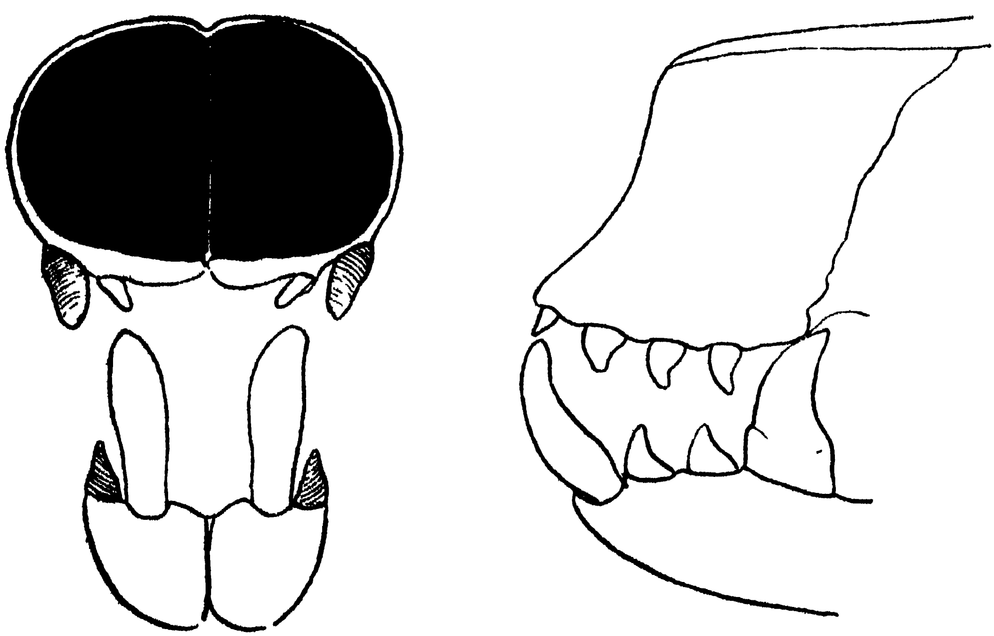


Fig. 4.
The anterior teeth of *Myrmecobius fasciatus* Front and side views.

various members of the genus *Phascogale* display the long, projecting, upper central incisors in a still higher degree of specialisation, and the condition is illustrated in *Phascogale penicillata* at fig. 2.

In the Native Cats the differentiation of the front teeth is not so pronounced; but, nevertheless, the peculiarity is quite obvious, for the upper central incisors cant forwards and are separated from each other and from their fellows. The lower central incisors are also large, distinct in form, and separated in the mid line The condition in *Dasyurus geoffroyi* is shown at fig 3.

Perhaps the most interesting modification of the anterior teeth is that seen in *Myrmecobius,* for here it is the lower incisors which are the most highly

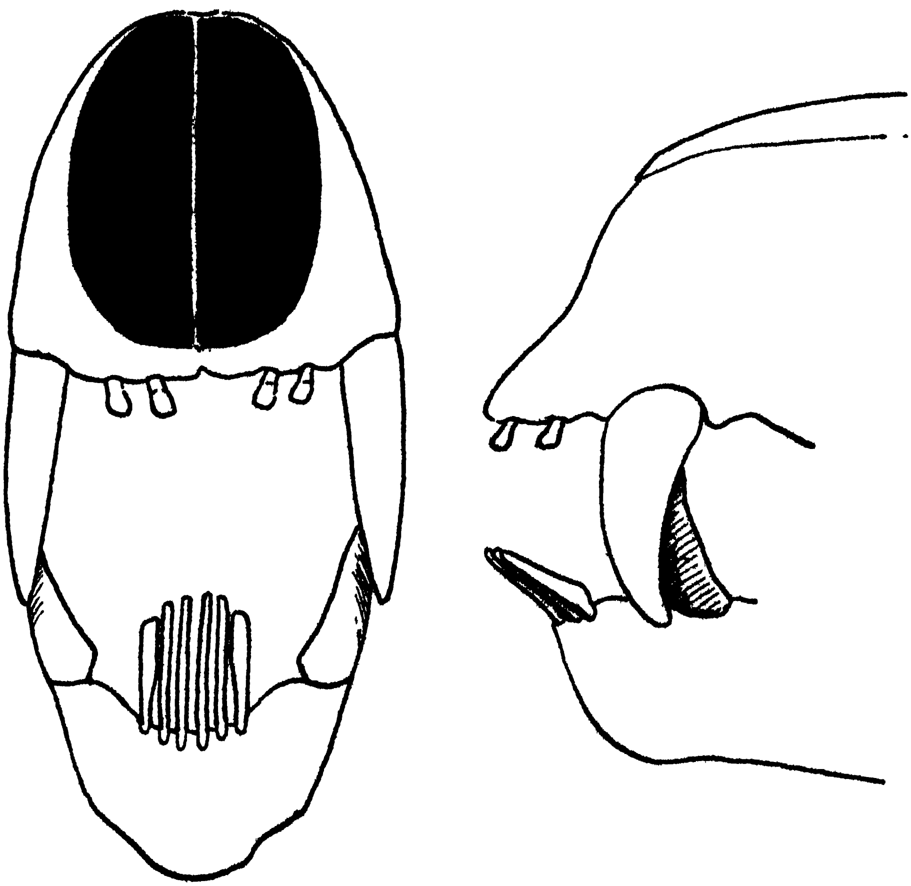


Fig. 5
The anterior teeth of *Lemur catta* Front and side views

specialised, the upper central incisors being very small but sharply pointed. In *Myrmecobius* the teeth are more widely separated in the mid line than they are in the Pouched Mice, and it is to be hazarded if this modification is associated with the coarse, hispid hairs which constitute the animal's coat. The lower central incisors of *Myrmecobius* are relatively very large teeth and are peculiar in their form (see fig. 4). The special interest attached to these teeth of the Numbat lies in the fact that the dentition of the creature is obviously in a state of degeneration. In the midst of this degeneration the two lower central incisors

stand out in marked contrast, and it might almost be said that they are practically the only undegenerate teeth that the animal possesses.

That mammalian teeth should be specialised as toilet implements is no novelty in the marsupials, for parallels are to be found in the monodelphians. Although Frédéric Cuvier, as long ago as 1829 (Hist. Nat. Mammif., p. 218) described the curious lower front teeth of the *Lemur* (see fig 5) as "veritables peignes," the fact is still not appreciated by some authors. W K. Gregory in his monograph on the Structure and Relations of *Notharctus* (Mem Amer. Mus. Nat. Hist., N.S., vol. iii., part ii., 1920, p. 203) has altogether overlooked this functional modification of the Lemur's lower front teeth and has ascribed their peculiarity to their being "pressed outward and forward by the greatly enlarged tongue."

In 1918 (Jour. Anat., vol. lii., p. 346) the present writer drew attention to the functional correlation between the lemurine sublingua and the peculiar procumbent front teeth, and noted the curious toilet specialisation of the front teeth of *Galeopithecus*. It is probable that patient observation of living animals will disclose many more instances of toilet modifications in the front teeth of the mammals. Meanwhile, this little contribution to the great study of structure and function demonstrates once again the vast plasticity of parts and organs, and especially of those, apparently, most rigid and stereotyped structures—the teeth. It demonstrates also how functions, which we might be apt to consider as trivial, demand their share of structural adaptations, and how, in the absence of a knowledge of function, however apparently humble it may be, deductions concerning structure are prone to be fallacious.

NEW GENERA AND SPECIES OF AUSTRALIAN STONE-FLIES (Order PERLARIA).

By R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.N.Z.Inst., F.L.S., F.E.S., C.M.Z.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

(Communicated by Edgar R. Waite.)

[Read September 11, 1924.]

Family EUSTHENIIDAE.

Genus Eustheniopsis, Till.

Proc. Linn. Soc. N.S. Wales, 1921, xlvi., p. 232.

Eustheniopsis venosa, Till.

Subspecies *brachyptera*, n. subsp. A very distinct race or subspecies of this handsome Victorian species was discovered by me on Mount Kosciusko, N.S. Wales, in November, 1921. It differs from the type form in its small size and shortened wings, and in the lunule of the forewing being very narrow, less than 1 mm. wide. Length of forewing 12 mm., of hindwing 10 mm., of body 20 mm.; antennae 12 mm., cerci 11 mm. Purplish-blue colouring of hindwings not quite so rich as in type form. Both the specimens taken were males.

Types: Holotype male and paratype male (Mount Kosciusko, N.S. Wales, 5,500 feet, November 24, 1921, R. J. T.), in Cawthron Institute collection.

Genus Thaumatoperla, Till.

Proc. Linn. Soc. N.S. Wales, 1921, xlvi., p. 224.

Thaumatoperla robusta, Till.

A half-grown larva of this fine species has recently been taken by Mr. Erasmus Wilson in a mountain stream near Mount Bencairn, Millgrove, Victoria, where both male and female specimens of this rare insect have also been found by Mr. Wilson and Mr. C. G. Barrett. The larva is black, with the thoracic sterna, sutures, and coxae yellow, the femora tinged with olive-green beneath. A similar larva, full-fed and of great size (about 45 mm. long), was taken by me on Mount Kosciusko, N.S. Wales, in Nov., 1921; the underside had the yellow colouration replaced by brick-red. Thus we may conclude that either *T. robusta* itself, or a related, undescribed species, is to be found on Mount Kosciusko.

♂. Hitherto undescribed, differs from female as follows:—Total length of body 19 mm., forewing 18 mm., cerci 18 mm. The parts of the meso- and metathorax, coxae, and femora, which were described as either brown or greyish-yellow in the female, are bright yellow in the male. Seg. 9 hollowed out posteriorly above, broadly yellow on either side; tenth tergite narrowly yellow. Supra-anal plate with a forwardly curved copulatory hook, rather short; paraprocts short, blunt.

Types: Holotype female in National Museum, Melbourne; allotype male in Cawthron Institute collection, Nelson, N.Z.; both from Warburton, Vict.; male dated 4, 1915.

Family AUSTROPERLIDAE.

Genus Tasmanoperla, Till.

Canadian Entomologist, 1921, p. 40.

The following new species, from Mount Kosciusko, N.S. Wales, has the characters of the genus clearly marked, but superficially resembles the New

Zealand *Austroperla cyrene* (Newm.) in the lack of any mottling of the wings and in the weakness of the cross-veins in part of the distal area of the forewings.

Tasmanoperla ruficosta, n. sp.

♀. Length of body 12 mm., of forewing 13 mm., antennae 9 mm., cerci 0·7 mm., with very few segments. Body, legs, and antennae black. Wings fuscous with black veins, except the whole of the costal space to end of R_1 in both wings, which is brick-red (fading to yellow-ochreous in dead specimens) with darker reddish-brown venation. Distal cross-veins between branches of Rs, M, and Cu_1 very weak, colourless, rest very strong and black.

Types: Holotype female and series of five paratypes, all apparently females (Mount Kosciusko, N.S. Wales, 5,500 feet, Nov. 24, 1921, R. J. T.), in Cawthron Institute collection, Nelson, N.Z. Two of the paratypes have slightly shortened wings, length of forewing being 11 mm.

Family LEPTOPERLIDAE.

Genus DINOTOPERLA, Till.

Canadian Entomologist, 1921, p. 43

Dinotoperla fasciata, n. sp.

♀. Length of body 6 mm., of forewing 10 mm., antenna 7 mm., cerci 1 mm. Head black, antennae dark brown; pronotum pale yellowish; rest of thorax black, abdomen dark brown. Forewings suffused with pale fuscous, venation darker fuscous; distal cross-veins surrounded by darker fuscous areas and so arranged that from three to four irregular transverse fasciae cross that part of the wing. Hindwings darker fuscous with a few darkened cross-veins placed distally between C, R_1, and Rs.

Types: Holotype female (National Park, Q'land, 1,500-2,000 feet., Dr. A. J. Turner), in Cawthron Institute collection, Nelson, N.Z.; paratype female, slightly smaller in size and with less distinct fasciae (same locality, Mar., 1921, G. H. Hardy), in Queensland Museum, Brisbane.

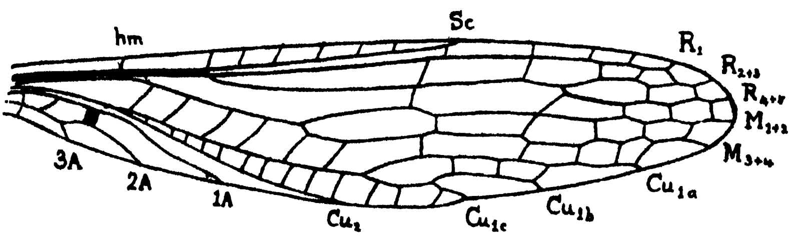


Fig 1.

Forewing of *Trinotoperla irrorata*, n. g. et sp. Length, 25 mm. 1A, 2A, 3A, the three anal veins; Cu_{1a}, Cu_{1b}, Cu_{1c}, the three branches of first cubitus; Cu_2, second cubitus; *hm*, humeral veinlet; M_{1+2}, M_{3+4} the two branches of media; R_1, main stem of radius; R_{2+3}, R_{4+5} the two branches of radial sector (Rs); Sc, subcosta.

Genus Trinotoperla, n. g.

Forewings with Rs forked distally, M forked near middle of wing, Cu_1 three-branched (sometimes in males the lowest branch is very short and forms a closed cell with the one above it); cubito-anal space without cross-veins; a thickened cross-vein between 1A and 2A. Hindwing with Rs distally forked, M forked, Cu_1 simple, or, more rarely, forked; apex narrowly rounded; anal fan rather narrow, without any cross-veins. Cerci short. Size of species large, expanding from 40 mm. to over 50 mm.

Genotype: *T. irrorata*, n. sp., from Mount Kosciusko, N.S. Wales.

Trinotoperla irrorata, n. sp.

♀. Length of body 20 mm., of forewing 25 mm., antennae 17 mm., cerci barely 3 mm. Body dark fuscous, marked with dull brown; antennae dull brownish with slight fuscous annulations; legs dull brownish varied with dark fuscous. Wings pale greyish with dark-fuscous veins, those of basal half of hindwing inclining to brownish; the whole of forewing and distal part of hindwing irrorated with darker spots and patches, and most of the cross-veins enclosed in darker areas. Forewing with a complete series of costal veinlets; hindwings with *hm* and three to four distal costal veinlets only. Thickened cross-vein between 1A and 2A in forewing blackish, very prominent.

♂. Smaller and slightly paler and less strongly irrorated than female. Body 17 mm., forewing 21 mm.; supra-anal plate with slender copulatory process directed upwards and ending in a small hook directed posteriad; paraprocts upcurved, forming two flatly rounded lobes directed forward and upward. Tenth tergite with a raised flap distally.

Types: Holotype female, allotype male, and paratype female (Mount Kosciusko, N.S. Wales, 5,000-5,500 feet, Nov. 24, 1921, R. J. T.), in Cawthron Institute collection, Nelson, N.Z.

Trinotoperla australis, n. sp.

♀. Length of body 14 mm., of forewing 20 mm., antennae 15 mm., cerci 2 mm. Body, legs, and antennae fuscous; metathorax, abdomen, and femora touched with brown. Wings pale brownish-fuscous, with darker venation and cross-veins enclosed in narrow darkened areas; no irroration present. Both wings with costal veinlets very incomplete, only *hm* and one or two distal costal veinlets being present. Thickened cross-vein between 1A and 2A of forewings inconspicuous, semi-transparent brownish.

Type: Holotype female (Towac, near Mount Canoblas, N.S. Wales, Oct. 7, 1916, R. J. T.), in Cawthron Institute collection, Nelson, N.Z.

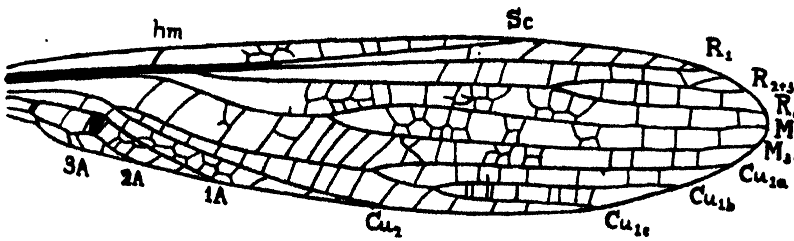


Fig. 2.
Forewing of *Eunotoperla kershawi*, n. g. et sp. Length, 25 mm. Lettering as in fig. 1.

Genus Eunotoperla, n. g.

Forewing with Rs distally forked or three-branched, M forked from near middle of wing, Cu_1 three-branched or, more rarely, simply forked; a thickened cross-vein between 1A and 2A; cells between M and Cu_1 partially double; cubito-anal space with cross-veins. Hindwing with Rs terminally forked or simple, M forked, Cu_1 forked or simple; apex well rounded; anal fan moderately wide, with a few weak cross-veins developed in region of 1A and 2A. Cerci short. Size of species large, expanding 50 mm. or more.

Genotype: *E. kershawi*, n. sp. (Vict.).

This genus shows an approach to the Eustheniidae in the beginning of the development of cross-veins on the anal fan, and is in other respects somewhat

similar in appearance to the genus *Stenoperla* of that family; it can be at once distinguished by the marked angle between the border of the anal fan and the rest of the hindwing, this angle being entirely absent in the Eustheniidae.

Eunotoperla kershawi, n. sp.

♂. Length of body (abdomen much shrunken) 11• mm., of forewing 25 mm., antennae 16 mm., cerci 4 mm. Body, legs, and antennae blackish, with front border of pronotum brownish. Wings dull brownish with dark-brown venation; cross-veins nearly all enclosed in pale transparent whitish areas; thickened cross-vein between 1A and 2A of forewing dark brown; supra-anal plate with a copulatory process in the form of a slender, downcurved spine; paraprocts with a pair of shorter, upcurved spines.

♀. Length of body (not shrunken) 25 mm., forewing 30 mm.; differs from male in having abdomen and pronotum brown, wings dark brown, the hindwings somewhat fuscous.

Types: Holotype male and allotype female (Warburton, Vict., 12, 94), in National Museum, Melbourne; paratype male, from same locality, in Cawthron Institute collection, Nelson, N.Z., also a male from Thorpdale, Gippsland.

Dedicated to Mr. J. A. Kershaw, F.L.S., Curator of the National Museum, Melbourne.

Family NEMOURIDAE.

Genus SPANIOCERCA, Till

Trans. N.Z. Inst., vol. liv., 1923, p. 216

The family has not previously been recorded from Australia, but is represented by species of this New Zealand genus in Tasmania and on the mountains of South-eastern Australia. Pending a more comprehensive study of the species, which are small and closely similar, the following species from Mount Wellington, near Hobart, is here described

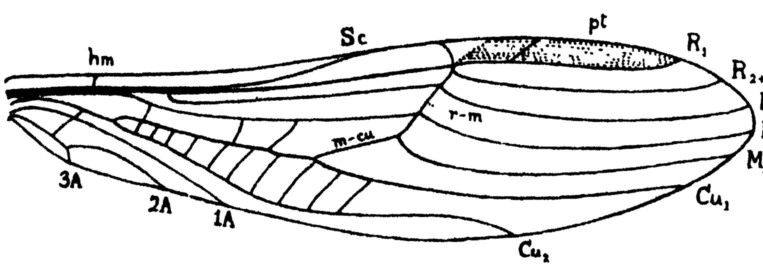


Fig. 3.

Forewing of *Spaniocerca tasmanica*, n. sp. Length, 10 mm Lettering as in fig. 1, except Cu_1 first cubitus; *m-cu*, medio-cubital cross-vein, and *r-m*, radio-median cross-vein, both forming part of the transverse cord; *pt*, ptero-stigma.

Spaniocerca tasmanica, n. sp.

♀. Length of body 11 mm., of forewing 10 mm., antennae 9 mm., cerci obsolescent. Head black, with occiput rich brown; antennae blackish. Thorax blackish; legs dark brown, with conspicuous black marks at both ends of femora and tibiae; tarsi blackish. Wings shining, semi-transparent, suffused with pale brown; hindwing markedly iridescent. Pterostigma of both wings conspicuous, long (about 3 mm.), brown. Somewhat hyaline areas present in forewing just distad from transverse cord and also on either side of basal half of Cu_1.

Types: Holotype female and allotype female (Mount Wellington, Tas., Jan. 31, 1917, R. J. T.), in Cawthron Institute collection, Nelson, N.Z.

REVISION OF THE AUSTRALIAN ELATERIDAE. COLEOPTERA.—Part I.

By Albert H. Elston, F.E.S.

[Read September 11, 1924.]

Family ELATERIDAE.

The insects comprising this family have the head sunk into the prothorax, almost up to the eyes, and it is always wider than long; the antennae are very variable in length, as long as the body or not even reaching the base of the pronotum, either filiform, serrated, combed, or even laminated and having either eleven or twelve joints; the upper lip is always visible, transverse or semicircular, and sometimes emarginate in the middle of the anterior margin; the maxillae are always small and bilobed, and at the apex with dense and somewhat long hairs; the maxillary palpi are always four-jointed; the basal joint is small, the following two variable in length, and the last one having different shapes, being either filiform, securiform, triangular or even cylindrical; the labial palpi are mostly short and three-jointed, the last joint, as with the maxilliary palpi, is of various shapes. The prosternum is elongate and, with one exception (Campylides), provided in front with a protuberance, generally rounded, projecting underneath the head, and frequently concealing the entire lower part; at the posterior end, the prosternum is abruptly contracted between the anterior legs and is prolonged into a projection, either straight or curved, which is received into a cavity in the mesosternum, and forming an important part of the curious mechanism which gives these insects the power of jumping or skipping, when they are placed on their backs. The scutellum is always visible, and the elytra are usually elongated. The legs are comparatively short and the tarsi five-jointed; the latter are either simple, more or less compressed, under surface clothed with hairs, sometimes very strongly dilated or flatly depressed, or the individual joints are bilobed, cordate or lobed.

The Elateridae in their larval stage are known as wireworms; they are distributed all over Australia and attack a variety of crops. They are particularly destructive to maize, wheat and oats, as well as to potatoes, sugar beets and sugar cane. When attacking the cereal and forage crops they work entirely beneath the surface of the ground, and their attention is chiefly confined to the seeds, roots and underground stems.

My work, up to the present, has been considerably lightened by the help of my colleagues in Australia generously loaning to me their collections, and I herewith desire to express my appreciation of the courtesy of the following gentlemen in this connection:—Mr. A. M. Lea of the South Australian Museum; Mr. J. Clark of Perth; Mr. H. J. Carter and Dr. E. W. Ferguson of Sydney; Mr. F. E. Wilson of Melbourne; Mr. J. C. Goudie of Maldon, Victoria; and Mr. R. F. Kemp of Adelaide.

Subfamily AGRYPNIDES.

The members of this subfamily have the mandibles dentate on the inside or cleft at the apex; the antennae seldom extend beyond the base of the pronotum and are received into the prosternal furrows formed by the separation of the lateral borders of the prosternum from the sides of the prothorax; the face is flat, or more or less depressed. The prosternum is sometimes provided

with deep furrows for the reception of the tarsi, of which the latter are either simple, clothed underneath with brush-like hairs, or sometimes one or two joints are lobed or dilated.

Key to the Genera of Agrypnides.

1.	The tarsi are simple	2
1*a*.	Joints 1 to 4 of the tarsi are strongly dilated, flatly depressed, and at apex emarginate	*Tricres*
1*b*.	Apex of first joint of tarsi strongly, the remainder less strongly, dilated	*Pseudolacon*
2.	The antennal furrows reach up to the anterior legs	3
2*a*.	The antennal furrows do not reach up to the anterior legs . .	5
3.	The 3rd joint of antennae is shorter than the 4th, or if quite as long, in this case at least narrower than the latter. The pronotum is more or less arched, the carina of the posterior angles extends upwards and parallel to the lateral margins	*Agrypnus*
5.	The antennae long and more or less pectinate .. .	*Homocolacon*
5*a*.	The antennae short and not pectinate	6
6.	Elytra at the base strongly contracted, on the shoulders obliquely truncate, the epipleurae not twice as long as wide	*Myrmodes*
6*a*	Elytra at the shoulders rounded or angular, the epipleurae more than twice as long as wide	*Lacon*

Genus Lacon.

This genus has a world-wide distribution and is largely represented in Australia. It may be distinguished by the following characteristics: The mandibles are bifid or dentate on the inside; the apical joint of the palpi is securiform. The antennae are short, the first joint is large and somewhat bent, the second and third small, the third sometimes somewhat shorter than the second, the following are triangular, the last at the apex truncate or emarginate. The pronotum may be more or less flat or yet strongly arched, usually wider than long or as long as wide, and sometimes it may be even longer than wide; the appearance, at first glance, of the relative length and breadth of the pronotum is very deceptive, usually it will appear to be longer than wide, but on actual measurements it may prove to be only as long as wide or even slightly wider than long. The elytra are wide and comparatively short, at the sides parallel, or dilated in, or before, the middle; usually punctate-striate or with seriate punctures. The antennal furrows on the prosternum only reach to the middle; the sides of the pro- and metasternum have sometimes sharply defined or slightly distinct tarsal furrows; at the base of the propleurae there is frequently a deep transverse furrow for the reception of the anterior femur. The legs are moderately long, the femora and the tibiae usually of equal length. The insects comprising this genus may be divided into four sections. The first, having the pro- and metasternum furnished with deep, sharply defined tarsal furrows, as with *L. caliginosus*, Guer.; the second section, to which *L. socius*, Cand., belongs, has the prosternum only with deep, sharply defined tarsal furrows, and the metasternum with ill-defined furrows, or even entirely absent; the third has the pro- and metasternum, or the prosternum only, with distinct, but not deep and sharply defined tarsal furrows, of which *L. assus*, Cand., is an example; and the fourth section is without tarsal furrows on the prosternum, or, if present, so ill-defined as to be almost indiscernible, this last section is represented by *L. variabilis*, Cand.

Synonomy.

L. gayndahensis, Macl.=*L. assus*, Cand.
L. squalescens, Blackb.=*L. marmoratus*, Cand.
L. bimaculatus, Schwarz=*L. duplex*, Blackb.
L. adelaidae, Blackb.=*L. carinulatus*, Cand.

Lacon caliginosus, Guerin.

Hab.—New South Wales; Victoria; South Australia; Tasmania.

LACON LATICOLLIS, Cand.

The posterior angles of the pronotum inside are lightly, but distinctly, carinate; a characteristic not mentioned by the author.

Hab.—Victoria; South Australia (Kangaroo Island); Western Australia.

LACON URSULUS, Cand.

This species is variable in size, specimens before me range from 9 mm. to 13·5 mm. in length.

Hab.—New South Wales; Victoria; South Australia.

LACON SOCIUS, Cand.

A specimen from the Endeavour River, Queensland, agrees very well with the author's description of this species, and has the posterior angles of the pronotum rectangular. A specimen in the South Australian Museum, however, determined by Candeze as *socius*, has not the posterior angles of the pronotum rectangular. The latter specimen has the sides of the pronotum, in front of the posterior angles, lightly sinuated, and from the bottom of this sinuation are continued rectilinearly in an oblique direction downwards, which gives the angles the appearance of being widely and obliquely truncated. The interstices on the elytra have two rows of punctures, much smaller than those in the striae, very distinct near the base and in the middle, but almost obsolete on the posterior third.

LACON FARINENSIS, Blackb.

Hab.—South Australia (Parachilna); New South Wales (Broken Hill).

LACON MANSUETUS, Blackb.

This species is very variable in colour, ranging from a dark brownish-black to a tawny tint. The pronotum has two more or less distinct subbasal round foveae, situated one on each side of the faintly defined longitudinal median furrow, midway between the latter and the lateral margins. . In general appearance it closely resembles *L. granulatus*, Macl., but can be easily distinguished from that species by the base of the pronotum being much less deeply emarginate, the posterior part of the elytra more widely rounded, the punctures on the pronotum larger and not granulated in appearance.

LACON ASSUS, Cand.

L. gayndahensis, Macl.

Macleay's species is undoubtedly conspecific with *assus*, and must now be regarded as a synonym of the latter. The author in his description of *gayndahensis* said that the prothorax is "longer than the width," but this is so only in appearance; by careful measurement the width proves to be barely greater than the length. Some specimens have the tuberculate prominence within the posterior angles of the pronotum more conspicuous than on others, whilst on some it is barely discernible. Length, 13 mm. to 16·5 mm.

Hab.—Queensland; New South Wales.

LACON COSTIPENNIS, Germ.

This species is very variable both in colour and size, the former ranges from a dark brown to a tawny colour, on some specimens the pronotum is dark brown and the elytra a reddish-brown, also in many instances the posterior angles of the pronotum are reddish; when abraded this insect has a distinct nitid appearance. The size varies from 6·5 mm. to 10·25 mm. in length.

Hab.—Victoria; South Australia; Kangaroo Island; Western Australia.

LACON LACRYMOSUS, Cand.

Some specimens are much paler than the typical form, being of a reddish-brown, although probably this may be due to immaturity. On fresh specimens the clothing is slightly of a mottled appearance, due to whitish scales being interspersed among the dark ones, especially is this noticeable on the pronotum and the elongate tubercles on the posterior part of the elytra. The posterior angles of the pronotum, on many specimens, are of a distinct reddish colour. This insect, as with *L. costipennis*, Germ., to which it is closely allied, has a nitid appearance when abraded. The length varies from 5·5 mm to 7·5 mm.

Hab.—South Australia.

LACON LINDENSIS, Blackb.

This species is very close to *L. lacrymosus*, Cand., and of which, probably, it is only a variety.

LACON GUTTATUS, Cand.

Closely allied to *L. pictipennis*, Cand., and of which, probably, it is only a variety. The size varies from 6 mm. to 8 mm. in length.

Hab.—Victoria; South Australia.

LACON MURRAYENSIS, Blackb

The only distinction, apparently, between this species and *L. guttatus*, Cand., and *L. pictipennis*, Cand., is that of its colour. For the present I am regarding these as three separate species, although I believe eventually they will prove to be but one variable species.

LACON PORRIGINOSUS, Cand.

The author in his description of this species does not mention anything about the puncturation of the interstices on the elytra. The specimens determined by me as *porriginosus* have the interstices strongly and closely punctured, the punctures being only slightly smaller than those in the striae. The colour is variable, some specimens being of a much lighter brown than others. The length varies from 8·5 mm. to 11 mm.

Hab.—North-west Australia; North Queensland.

LACON MARMORATUS, Cand.

L. squalescens, Blackb.

I have examined a cotype of *L. squalescens*, Blackb., which is in the South Australian Museum, and it is undoubtedly the above species, of which Mr. Lea has specimens in his collections determined by Candeze. It is a somewhat variable species, the colour of some being a much lighter brown than others; the longitudinal furrow on the pronotum is very finely impressed, whilst on several specimens it is almost obsolete. The length varies from 7·5 mm. to 10·5 mm.

Hab.—Queensland; New South Wales.

LACON VICTORIAE, Cand.

Hab.—Queensland; New South Wales; Victoria; South Australia; Tasmania.

LACON DUPLEX, Blackb.

L. bimaculatus, Schwarz.

The species described by Schwarz as *bimaculatus* is, apparently, the same as that described by Blackburn as *duplex;* the former must now be regarded as a synonym of the latter.

Hab.—New South Wales; Victoria; South Australia.

LACON CASTELNAUI, Cand.

The tarsal furrows on the prosternum are clearly indicated, but are neither deep nor sharply defined; those on the metasternum are almost obsolete.

LACON SCULPTUS, Cand.

Hab.—Queensland; New South Wales; Victoria.

LACON DIVARICATUS, Cand.

Hab.—Queensland; New South Wales; Victoria; South Australia.

LACON GRANULATUS, Macl.

On one specimen the dark scales on the pronotum are interspersed with whitish ones, and forming four more or less distinct maculae. The pronotum, by measurement, is about as long as wide and not "much longer than the width" as stated by the author, although, in appearance the length seems to be greater than the width. On the pronotum there are two small, shallow foveae, situated one on each side, and near to the almost obsolete longitudinal furrow, and just in front of the base. The antennae, anterior margins and posterior angles of the pronotum are more or less reddish. The prosternum has somewhat distinct tarsal furrows and those on the metasternum almost obsolete.

LACON DUBOULAYI, Cand

The insect which I have determined as the above species differs from the typical form in size, its measurements being 19 mm. long and 7·5 mm. wide, and, in addition, a moderately wide, shallow, tarsal depression is distinctly visible on the prosternum; in all other respects it agrees very well with the author's description.

LACON PRINCEPS, Cand.

Two specimens from Coen River, Queensland, are smaller than the typical form, one is only 20 mm. in length and the other 22 mm.

LACON GIBBUS, Cand.

A specimen from the Northern Territory only measures 17·5 mm. in length.

LACON CRASSUS, Cand.

There is a single specimen before me from Queensland which agrees very well with the author's description, except that there is a more or less distinct, short, shallow tarsal depression on the prosternum.

LACON VARIABILIS, Cand.

This species, as its name implies, is indeed very variable, and is commonly distributed over the whole of Australia and Tasmania. On some specimens, particularly with the male, the tarsal depression is more or less visible, whilst on others it is entirely absent; the sculpture of the elytra also shows a certain amount of variability, the alternate interstices being more conspicuously elevated on some specimens than on others; the length varies from 7·5 mm. to 14·5 mm. A careful comparison of the type of *L. yilgarnensis*, Blackb., with a series of the above species would probably reveal it to be only a variety of *variabilis*, of which the latter, having a wide distribution, is variable *inter se*. The present location of the type of *yilgarnensis* is unknown to the author, who considers it desirable for the present that these two species should be considered as separate until such time that Blackburn's type can be examined. Apparently the only distinction

between these two insects is that *yilgarnensis* has the margins of the pronotum less flattened and the tarsal furrows on the prosternum more conspicuous.

LACON INCULTUS, Macl.

Hab.—North-west Australia; Northern Territory

LACON PLEURETICUS, Cand.

This species has a moderately wide, shallow depression on the prosternum for the reception of the tarsi. On the inside of the posterior angles, close to the lateral margins, is a very fine, but nevertheless distinct, carina. The interstices of the elytra have each two rows of punctures, much finer than those in the striae, and the alternate striae are each more densely squamose than the others.

LACON VARIOLUS, Cand.

The tarsal furrows on the metasternum are almost as distinct as those on the prosternum. The interstices of the elytra near the suture are moderately wide and flat and, *inter se*, equal; towards the lateral margins they are more narrow and costate, the interstices near suture have each two rows of punctures, smaller than those in striae.

LACON GEMINATUS, Cand

Specimens from King River, Northern Territory, agree very well with the author's description, except that they are much smaller and variable in size, the smallest being 10 mm., and the largest 13 mm., in length.

LACON CARINULATUS, Cand.

L. adelaidae, Blackb.

On a large number of specimens examined by me there are to be seen two more or less distinct round foveae on the pronotum, one on each side of the longitudinal furrow, just in front of the base, and about midway between the former and the lateral margins; a characteristic not mentioned by either of the above authors. The elytral sculpture of this insect varies considerably, on some forms the alternate interstices are more elevated than on others, agreeing well with what Candeze wrote, "les intervalles impairs élevés en forme de petites côtes nettement saillantes." In the series before me there are to be found also specimens agreeing with what Blackburn wrote about *adelaidae*, "the alternate interstices of its elytra by no means strongly carinate" The intermediate stages between these two forms are also before me, so that I feel convinced the insect described by Blackburn as *adelaidae* is the same species as that described by Candeze as *carinulatus*. The length varies from 5·75 mm. to 7·5 mm.

Hab.—South Australia; Victoria.

LACON PLAGIATUS, Cand.

There are a number of specimens before me which undoubtedly appear to be this species. The colour of the body, on both the dorsal and ventral surfaces, is dark brown, with the exception of the posterior angles of the pronotum, which are sometimes strongly diluted with red; the antennae and legs are testaceous, the latter somewhat darker than the former. The posterior angles of the pronotum are acute and with a more or less distinct, fine carina on each near the outer margin; the punctures in the striae are almost round, those of the interstices also round but smaller. Length, 7 mm. to 9·5 mm.; width, 2·5 mm. to 3·75 mm.

Hab.—North-west Australia (Derby); Northern Territory (Daly River); Queensland (Cairns, Coen River, Cunnamulla, Normanton, Stewart River); South Australia (Oodnadatta).

Lacon perplexus, n. sp.

Wide, moderately convex; subnitid; reddish-brown, pronotum and head slightly darker, antennae and epipleurae of elytra reddish; moderately thickly clothed with yellow squamose hairs. Head flat, with a small shallow depression near the top; punctures concealed by the clothing. Pronotum transversely gibbous behind the middle, wider than long, sides roundly contracted on the anterior third, thence straight to the base, which is subtruncate, posterior angles rectangular and very finely carinate; with closely placed, moderately large, sieve-like punctures, becoming smaller and more crowded near the margins. Scutellum almost round with a few large punctures. Elytra of the same width as pronotum at the base and barely twice its length, sides almost parallel to beyond the middle then roundly narrowed to apex, slightly flattened in the middle near suture; punctate-striate, the punctures in striae large and more or less oblong in shape, the interstices flat and very finely punctured. Prosternum with deep, sharply defined furrows for the reception of tarsi, metasternum with very shallow and wide depressions. Length, 10-14·5 mm.; width, 4·25-5·5 mm.

Hab.—North-west Australia: Forrest River (W. Crawshaw), Hammersley Range (W. D. Dodd), Wyndham (W. Crawshaw); Northern Territory: Port Darwin. Type in author's collection.

The longitudinal furrow on the posterior part of the pronotum is not quite deep enough to divide the transverse gibbosity; the punctures in the elytral striae are much larger near the lateral margins than elsewhere, and those on the interstices more distinct near the base. The specimen from Port Darwin differs from the typical form in being of a uniform dark brown. Very close to *L. socius*, Cand., but wider in proportion to length, more nitid, and with the punctures in the elytral striae larger. Distinguished from *L. incultus*, Macl., by being proportionately broader and with the interstices on the elytra wider.

Lacon impressicollis, n. sp.

Moderately flat and wide; of a uniform dark brown with the antennae, palpi, posterior angles of prothorax, scutellum, epipleurae of elytra and legs reddish; densely clothed with very small, light-brown scales. Under surface brown, diluted with red and less densely clothed than upper surface. Head moderately flat and lightly impressed in the middle near the top; with dense, not large, rugose punctures. Pronotum wider than long, the sides roundly contracted on the anterior third, thence straight to the base, which is subtruncate; posterior angles rectangular, and almost imperceptibly carinate, depressed inside the anterior and posterior angles; longitudinally impressed in the middle, and with two distinct, round subbasal depressions, one on each side of the longitudinal furrow; densely covered with moderately small, round punctures. Scutellum almost round, slightly convex, and minutely punctured. Elytra as wide as pronotum at the base and less than twice the length of the latter; sides straight and almost parallel to just beyond the middle, thence strongly, roundly narrowed to apex; somewhat flattened on top near the suture; punctate-striate, the punctures in striae moderately large and deep, the alternate interstices wider and more elevated, minutely punctured. Prosternum with moderately deep, but not sharply defined, tarsal furrows. Length, 6·75-8·5 mm.; width, 3-3·75 mm.

Hab.—Tasmania: George Town, Ben Lomond (4,000 feet). Type in South Australian Museum.

In form somewhat resembling *L. laticollis*, Cand., but with the pronotum less convex, the elytra sculptured differently, and the tarsal furrows on the prosternum not sharply defined. Allied to *L. sculptus*, Cand., but easily distinguished by the shape of its pronotum, the punctures of which are much smaller, the upper surface more densely covered with scales and with the sculpture of the elytra different.

Lacon validus, n. sp.

Thick, convex; subopaque; dark brown with the antennae (basal joint excepted), tibiae and tarsi reddish; moderately densely clothed with griseous-yellow, squamose hairs, on parts of elytra more thickly arranged and forming patches. Under surface same colour as upper, densely and uniformly clothed with very small pale scales. Head with surface very uneven and thickly covered with rather large punctures. Pronotum wider than long, transversely gibbose behind the middle, and with an indistinct longitudinal furrow posteriorly, sides roundly contracted on the anterior third and sinuate in front of the posterior angles, finely crenulate; posterior angles moderately large, slightly divergent, and widely and obliquely truncated, indistinctly carinate; impressed inside the anterior and posterior angles, the latter more deeply than the former; closely covered with rather large punctures, becoming smaller near the margins. Scutellum pentagonal, slightly concave and acuminate behind. Elytra as wide as pronotum and slightly more than twice its length, sides barely perceptibly dilated near the middle, then roundly contracted to apex; punctate-striate, the punctures in striae moderately large and almost round, the interstices wide and flat, each with two rows of punctures which are smaller and more shallow than those in striae. Prosternum and metasternum with wide, shallow tarsal depressions, those on the former much more distinct than those on the latter. Length, 13-15 mm.; width, 5-5·5 mm.

Hab.—Queensland: Bowen (A. Simson). Type in South Australian Museum.

The clothing is more patchy on the posterior part of the elytra than elsewhere and arranged so as to form two or three more or less distinct fasciae; the head has three or four large depressions which give its surface a very uneven appearance, also slightly granulated on the vertex; the interstices of the elytra are distinctly granulated near the base. Distinguished from *L. crassus*, Cand., by the patchy appearance of the clothing on the elytra, the uneven surface of the head, and the prosternum with distinct tarsal impressions.

Lacon productus, n. sp.

Elongate, moderately convex; subopaque; reddish-brown with the antennae, posterior angles of prothorax, scutellum and legs more reddish; moderately densely clothed with short, yellowish-grey, squamose hairs Under surface somewhat paler than upper and similarly clothed. Head triangularly impressed in the middle, and with closely arranged, rather small punctures. Pronotum about as long as wide, sides roundly contracted on the anterior fourth, thence straight to the base which is subtruncate; transversely gibbose behind the middle and with the gibbosity feebly divided by a shallow longitudinal furrow which extends almost the whole length of the pronotum; posterior angles almost rectangular and very feebly carinate; with moderately dense, small, round punctures, smaller and more crowded near the sides. Scutellum vaguely pentagonal, more or less rounded posteriorly, slightly concave and feebly punctured. Elytra as wide as pronotum and about two and a half times as long, sides parallel to beyond the middle then roundly contracted to apex; punctate-striate, the inside striae with small round punctures, those of the outer ones

much larger and more or less quadratic, the interstices rather wide and flat, minutely punctured. Prosternum with shallow, but nevertheless distinct, tarsal depressions. Length, 9 mm.; width, 3 mm.

Hab.—Northern Territory: Darwin (W. K. Hunt). Type in South Australian Museum.

The clothing on the elytra is arranged in double rows on each of the interstices; the sides of the pronotum in front of the posterior angles are not at all sinuate. In general appearance somewhat resembling *L. caliginosus*, Guer., but smaller, more convex, and with the sculpture of the elytra and tarsal furrows different.

Lacon orthoderus, n. sp.

Elongate, narrow, convex; brown, in parts feebly diluted with red, the greater portion of head, antennae, and parts of the legs reddish; moderately densely clothed with pale griseous, acuminate scales. Under surface somewhat more reddish than above and similarly clothed. Head widely and somewhat deeply impressed in the middle, closely and rugosely punctured. Pronotum longer than wide, evenly convex, with a feeble, longitudinal, median furrow on the posterior half; sides on the anterior fourth roundly and feebly contracted, thence straight and parallel to the base, which is widely sinuate, lateral margins slightly crenulate; anterior and posterior angles lightly impressed on the inside, the latter subacute and produced backwards. Scutellum almost round, closely and finely punctured. Elytra as wide as pronotum and about twice the length, sides parallel to near the middle, then roundly contracted to apex; punctate-striate, the punctures in striae very dense and small, the interstices not wide, flat, and minutely punctured and granulate. Prosternum without tarsal depressions. Length, 7·5 mm; width, 2 mm.

Hab.—Northern Territory (Blackburn's collection). Type in South Australian Museum.

The pronotum is evenly convex and not transversely gibbose, as is the case with most of the convex species of this genus; easily distinguished by the sculpture of the elytra. Near *L. productus*, Elston, but more slender, without tarsal depressions on the prosternum and the punctures smaller and more crowded.

Lacon scopulosus, n. sp.

Thick; subopaque; dark brown, with the antennae and legs a reddish-brown; moderately densely clothed with whitish-grey scales, on parts of the elytra somewhat more densely arranged and of a more whitish colour, which gives it a mottled appearance. Under surface same colour as above and moderately densely clothed with pale scales. Head almost semi-circular and flat with a shallow depression in the centre; closely punctured and distinctly granulated. Pronotum wider than long, transversely gibbose behind the middle, sides crenulate and abruptly contracted on the anterior third, thence straight to the base, which is almost straight; posterior angles subrectangular with the apex obliquely truncated; with small, closely arranged, subrugose punctures. Scutellum almost round and more or less concave. Elytra barely perceptibly wider than pronotum and about twice the length of the latter, evenly convex, sides very slightly dilated near the middle, then roundly contracted to apex; rather deeply punctate-striate, the interstices not wide, more or less flat, and on the basal half distinctly granulated. Prosternum with short, very indistinct, tarsal furrows. Length, 5-5·5 mm.; width, 2 mm.

Hab.—Queensland: Coen River (W. D. Dodd); Endeavour River. Type in South Australian Museum.

A small, thick, and very distinct species, with the clothing denser at the base and more patchy on the posterior part of elytra. The elytra, in parts, are

sometimes diluted with red and with the posterior angles of the pronotum more or less reddish; the sides of the pronotum in front are almost rectilinearly contracted and the longitudinal furrow in the middle, which is usually present on species of this genus, is absent. A smaller species than *L. pinguis*, Cand., the clothing different and with the posterior angles of the pronotum truncated.

Lacon adustus, n. sp.

Moderately thick; convex; subopaque; brown; in parts diluted with red, with antennae and legs reddish; rather densely clothed with tawny, squamose hairs, more densely arranged in parts and forming patches. Under surface convex; subnitid; reddish-brown and somewhat densely and evenly covered with testaceous squamose hairs. Head widely and rather deeply depressed in the middle; closely, deeply, and somewhat rugosely punctured. Pronotum wider than long, transversely gibbose behind the middle, more or less narrowly flattened inside the lateral margins which are crenulate; without a longitudinal furrow in the middle, sides somewhat abruptly contracted on the anterior third and from thence to the base almost straight, slightly sinuate in front of the posterior angles, which are widely and obliquely truncated on the outside, acuminate at the apex and carinate, the carina continued up to about the anterior third and forming a double edge; with moderately large, deep, and closely placed punctures, becoming smaller and somewhat more crowded near the margins. Scutellum pentagonal, acuminate behind and convex. Elytra slightly wider than base of pronotum and a little more than twice the length of the latter, evenly convex, sides somewhat dilated near the middle, then gradually and roundly contracted to apex; punctate-striate, the punctures in striae more or less rectangular, the interstices flat and even, minutely punctured and tuberculate near the base. Prosternum with shallow, more or less distinctly visible, tarsal furrows. Length, 8-12 mm.; width, 3-5 mm.

Hab.—Queensland: Cairns (A. M. Lea), Coen River, Stewart River (W. D. Dodd, Townsville (N. B. Tindale), Malanda (Dr. E. Mjöberg). Type in South Australian Museum.

On some specimens the epipleurae of the elytra are reddish; there is no longitudinal furrow on the middle of the pronotum, or at the most only barely perceptible on the basal part; the carina begins from the top of the truncation of the posterior angles of the pronotum and extends upwards to about the anterior third, forming a more or less distinct double margin. Five specimens (Cairns [2] and Malanda [3]) differ from the typical form by having the clothing much brighter; the squamose patches on the elytra are more or less golden and those on the prothorax silvery. In general appearance it closely resembles *L. marmoratus*, Cand., but distinguished from that species by not having the pronotum longitudinally furrowed in the middle, the interstices on the elytra more finely punctured and distinctly granulate near the base.

Lacon submarmoratus, n. sp.

Elongate; moderately convex; subopaque; ferruginous with blackish patches; antennae, posterior angles of pronotum, epipleurae and legs a clearer red; moderately densely clothed with testaceous squamose hairs, more densely arranged on parts of elytra and pronotum and forming patches. Under surface of a more uniform ferruginous and with clothing similar to upper surface but more densely arranged. Head almost circular, with a large flat depression in the centre; somewhat coarsely punctured, the punctures more or less concealed by the clothing. Pronotum slightly longer than wide, base narrower than width at the anterior third, from the latter place abruptly, strongly, and rectilinearly contracted to anterior margin, lateral margins behind almost straight, very

slightly sinuate in front of the posterior angles, which are widely and obliquely truncated; lateral margins inside rather widely flattened, the longitudinal furrow just barely visible on the posterior half; closely covered with moderately large round punctures. Elytra as wide as pronotum and about two and a half times as long, sides almost parallel from base to middle and from thence gradually, roundly contracted to apex; punctate-striate, the punctures in striae rather small and rectangular, but becoming larger towards lateral margins, the interstices almost flat and with minute punctures, which are concealed by the clothing, distinctly granulate on the basal third. Prosternum with shallow, not very distinctly defined tarsal depressions. Length, 9-11 mm.; width, 2·75-3·75 mm.

Hab.—Queensland: Cairns (A. M. Lea). Type in South Australian Museum.

The antennae are comparatively long, almost reaching to the base of the pronotum; the elytra are much attenuated posteriorly. The scales on the latter are arranged in longitudinal rows and in parts more densely placed so as to form patches, particularly on the posterior half; the clothing on the pronotum is also irregular and so arranged as to appear in parts like guttae. This species is very close to *L. marmoratus*, Cand., but more elongate, antennae longer, pronotum rectilinearly contracted in front, with the lateral margins not crenulate and more widely flattened inside, and with the tarsal furrows on the prosternum not so strongly and clearly impressed.

Lacon applanatus, n. sp.

Elongate; rather flat; subnitid; upper surface dark brown with the antennae, palpi, legs, and posterior angles of pronotum reddish; moderately densely clothed with minute testaceous scales, which are seriate on elytra. Under surface same colour as upper but with the gula more or less reddish and the abdomen in parts diluted with red; somewhat densely clothed with small testaceous scales, more conspicuous than those on the upper surface. Head with three large depressions; densely covered with very small rugose punctures. Pronotum about as long as wide, lightly convex, abruptly and almost rectilinearly contracted from about the anterior fourth to base, from thence straight to posterior angles, in front of the latter slightly sinuate, sides not crenulate, the longitudinal furrow rather vague, the posterior angles almost imperceptibly produced backwards, the outer margin curved and slightly rounded off at the apex, with a very fine, but nevertheless distinct, carina; closely covered with small, round punctures. Scutellum small, truncate in front and rounded behind, minutely and rugosely punctured. Elytra as wide as pronotum and a little more than twice as long, almost flat on the middle with a narrow margin at the sides gently sloping, lateral margins vaguely dilated near the middle, from the posterior third gradually and roundly contracted to apex; punctate-striate, the punctures in rows moderately large and round, the interstices with densely placed punctures, a little smaller than those in striae, the alternate ones slightly elevated. The tarsal furrows on prosternum are almost indiscernible. Length, 8-11 mm.; width, 2·5-3·5 mm.

Hab.—Western Australia, Type in author's collection.

The pronotum of this species is much more nitid than the elytra, and on some specimens the latter has a narrow margin at the suture and the sides of a more or less reddish tint; the fifth interstice of the elytra is distinctly more elevated than the others. It differs from *L. monachus*, Cand., by not having the posterior angles of the pronotum acuminate, more nitid and more depressed.

Lacon conspiciendus, n. sp.

Moderately thick; subopaque; dark brown, with the antennae, palpi, and parts of the legs ferruginous; somewhat thickly clothed with short, acuminate,

testaceous scales. Face with a large, shallow, triangular depression in the middle, the apex of which touches the anterior margin of the pronotum; closely and somewhat rugosely punctured. Pronotum longer than wide, convex, sides curved and much constricted in front of the posterior angles, which are strongly produced backwards, obtusely pointed at the apex and distinctly carinate; median longitudinal line feebly marked, with two rather large, deep, round foveae in front of the middle, and two less distinct ones in front of the base, situated two on each side of the median line and midway between the latter and the lateral margins; closely covered with rather large and almost round punctures. Scutellum flat, more or less rounded posteriorly and lightly punctured in the middle. Elytra at the base much narrower than pronotum and less than twice the length of the latter, the sides at the anterior fifth abruptly dilated from the base, from thence to just beyond the middle almost parallel, then suddenly contracted to apex; the top, between the fifth suture on each elytron, slightly depressed; punctate-striate, the punctures in striae large and round, but becoming much smaller posteriorly; the interstices sparsely covered with minute punctures, which are concealed by the clothing, the fifth and seventh distinctly elevated, the remainder more or less flat. Prosternum without any distinct tarsal impressions. Length, 12-13·5 mm.; width, 4-4·5 mm.

Hab.—Northern Territory: King River. Type in South Australian Museum.

A very distinct and unlike any previously described species, it is easily distinguished by the unusual shape of the pronotum and elytra, the former by its strongly produced posterior angles and the two conspicuous foveae near the middle, and the latter by having the anterior fifth and the posterior third abruptly contracted.

Lacon commutabilis, n sp.

Moderately thick; subopaque; dark brown, with antennae and mouth parts a pale, and the legs a darker ferruginous; moderately densely clothed with pale, squamose hairs. Under surface more densely clothed, of the same colour as upper, and with shorter and more depressed scales. Face almost semicircular and slightly depressed on the anterior part; somewhat deeply and closely punctured. Pronotum about as wide as long, evenly convex, sides roundly contracted on the anterior third and from the middle gradually contracted to near base; posterior angles rather strongly divergent and produced backwards, obtusely pointed, finely carinate, the carina extended along the sides up to the base of the anterior angles and forming a more or less distinct double edge to the margins; the longitudinal median furrow almost obsolete, only on the posterior half barely visible; on the middle with rather closely placed, large, round punctures, but becoming smaller and denser towards margins. Scutellum truncate in front and rounded behind, slightly concave in the middle with a few moderately large punctures. Elytra at base barely as wide as pronotum between apices of posterior angles slightly depressed near suture, humeral angles rounded, sides almost straight and parallel to beyond middle then gradually and roundly contracted to apex; punctate-striate, the punctures in striae elongately rectangular, those in the striae near suture much smaller than those near lateral margins; interstices moderately wide and flat, minutely punctured and very finely transversely rugose. Prosternum without distinct tarsal furrows. Length, 14·5-18 mm.; width, 5-6·25 mm.

Hab.—Northern Territory: Port Darwin (W. K. Hunt, coll. of Dr. E. W. Ferguson); North-west Australia: Derby (W. D. Dodd), Noonkanbah (Dr. E Mjöberg). Type in author's collection.

This species is variable in size and with some the colour is a more reddish-brown than the typical form; the posterior angles of the pronotum are more or less reddish and at the apex are not sharply truncated but somewhat rounded.

Lacon arbitrarius, n. sp.

Not thick; subnitid; ferruginous, with the epipleurae and parts of the under surface paler; moderately densely clothed with short, pale, squamose hairs. Face almost flat with a small shallow depression near the centre and with small, densely arranged punctures. Pronotum about as wide as long, evenly convex, sides rounded, sinuate in front of the posterior angles, which are slightly divergent and produced backwards, acute and very finely carinate, the carina continued up to the anterior angles and forming a more or less distinct double margin; with round punctures, not large, less crowded in the middle than at the sides. Scutellum pentagonal, anterior margin lightly emarginate, posterior obtusely angled, middle concave with a few round punctures more or less concealed by the clothing. Elytra at base as wide as pronotum and a little more than twice as long, slightly flattened on top near suture, sides almost straight and parallel to beyond middle, then gradually roundly contracted to apex; punctate-striate, the punctures in striae moderately large, deep, and almost round, the interstices rather wide, flat, and minutely punctured. Tarsal furrows on prosternum very shallow. Length, 10·5-13·5 mm.; width, 3·5-4·5 mm.

Hab.—North-west Australia: Derby, Kimberley district (Dr. E. Mjoberg). Type in author's collection.

Two specimens are paler than the typical form and have the anterior margin of the pronotum, base of elytra, and margins of scutellum more or less infuscated. This species closely resembles *L. commutabilis*, Elston, from which it can be distinguished by its smaller size, punctures on pronotum more scattered and smaller and, chiefly, by the different shape of the posterior angles of the pronotum, which are much smaller and acute.

Lacon bigener, n. sp.

Moderately thick; not opaque; dark reddish-brown, with the antennae, posterior angles of pronotum and legs ferruginous; moderately densely clothed with acuminate, testaceous, squamose hairs. Under surface same colour as upper but with the epipleurae more or less reddish; rather densely clothed with short, depressed, testaceous, acuminate and squamose hairs. Surface of head somewhat uneven; deeply and closely punctured. Pronotum about as wide as long, rather strongly convex and transversely ridged behind the middle, the posterior half with a feebly impressed longitudinal furrow, sides on the anterior third roundly contracted, near the middle rather strongly curved and sinuate in front of the posterior angles, which are acute, slightly divergent and produced backwards, finely carinate, the carina continued upwards to beyond the middle and forming a more or less distinct double edge to the sides; with densely arranged, large, almost round punctures, becoming smaller towards the margins. Scutellum truncate in front, almost rounded behind, and with the lateral margins concave; with a few small punctures in the centre. Elytra as wide as pronotum and about twice as long, convex but flattened near suture, humeral angles obtusely pointed, sides near middle slightly dilated; punctate-striate, the punctures in rows moderately large, deep and almost round, the interstices rather narrow and almost flat, minutely punctured. Tarsal depressions on prosternum barely discernible. Length, 10-13 mm; width, 4-4·75 mm.

Hab.—Northern Territory: Port Darwin (W. K. Hunt). Type in South Australian Museum.

The punctures in the first elytral stria are smaller than the others, the flattened surface on top extends on each side of the suture to the second stria. This species comes between *L. commutabilis*, Elston, and *L. arbitrarius*, Elston; it differs from the former, *inter alia*, by having the posterior angles of the pronotum smaller and more acute, and from the latter by the punctures on the pronotum being larger and more crowded.

NOTES ON AUSTRALIAN CRUSTACEA.
No. III.

By HERBERT M. HALE.
(Contribution from the South Australian Museum.)

[Read September 11, 1924.]

ISOPODA-VALVIFERA from South Australia

The number of species of this tribe listed as occurring in Australian waters is small, and very few have been recorded from our State. There is little doubt that many forms remain to be collected, for, as remarked by Dr. Collinge,[1] "There is no reason to suppose that the South Pacific and Antarctic regions are any poorer in genera and species than the North Pacific and Arctic regions, although few have yet been obtained from the former regions."

Species of five genera not hitherto noted from Australia are herein described. In the specific descriptions the seven visible or "free" segments of the peraeon are referred to as the first to seventh segments, and the appendages of these somites as peraeopods.

Group I. ASTACILLINEA [2]

In 1882 Haswell described *Arcturus brevicornis*, from New South Wales, and *A. longicornis*, presumed to be from Tasmania; judging from Haswell's figure the former species should be referred to *Astacilla*. Four years later Beddard added *Arcturus abyssicola* from off North-eastern Australia, etc., and *A. oculatus*, which has been taken in New South Wales and Southern Victoria. Whitelegge, in 1904, described five species—*Arcturus simplicissimus*, *A. dentatus*, *A. alcicornis*, *A. nodosus*, and *A. serrulatus*—dredged by H.M.C.S. "Thetis" in New South Wales waters.

Family ASTACILLIDAE.

Key to Australian Genera.

a. Fourth free peraeon segment much longer than any of the others.
- *b.* First free peraeon segment not fused with cephalon. Pleon composed of two somites, with distinct articulation . . . *Astacilla*
- *bb.* First free peraeon segment fused with cephalon. Pleon composed of one somite, the articulations fused.
  - *c.* Antennae very stout, compressed. Anterior four peraeopods stout, flattened, fringed with strong setae . . *Parastacilla*
  - *cc.* Antennae moderately stout. Anterior four peraeopods slender, fringed with long, fine hairs . . . . . *Neastacilla*

aa. Fourth free peraeon segment not much longer than any of the others *Arcturus*

Parastacilla, n. gen.

Form much as in *Astacilla*. Second antennae raptorial, stout, compressed. Maxillipeds moderately wide, with five-jointed palp and large epipodite. First free peraeon segment fused with cephalon, the lateral parts expanded downwards and forwards and fused to the infero-lateral portion of the head. Anterior four pairs of peraeopods stout, flattened and armed with strong setae. Pleon unisegmentate, with indistinct indications of three fused sutures.

Type *P. truculenta*, n. sp.

(1) Clinge., Journ. Linn. Soc., Zool., xxxiv., 1918, p. 71.

(2) Clinge., *loc. cit.*

Key to Species.

a Peraeon segments without large dorsal spines . .. *truculenta*
aa Third and fourth free peraeon segments each with a large dorsal spine *bakeri*

Parastacilla truculenta, n. sp.

Fig 1

♀. Cephalon subglobose, dorsally tumid; anterior margin deeply excavate, very slightly produced medianly. Eyes small, subtriangular. First antennae reaching to end of second article of peduncle of second antennae; basal article laterally dilated, second twice as long as third and equal in length to flagellum, which is slender, uniarticulate, and bears sensory appendages at the distal end only. Second antennae large, stout, compressed; first article of peduncle very small; second shorter than third, which is half as long as fourth; fifth article about one-fifth longer than fourth; flagellum short, less than one-third as long as the fifth peduncular segment. Outer lobe of first maxillae capped with nine strong spines and one weaker spine. Maxillipeds with pinnate marginal hairs;

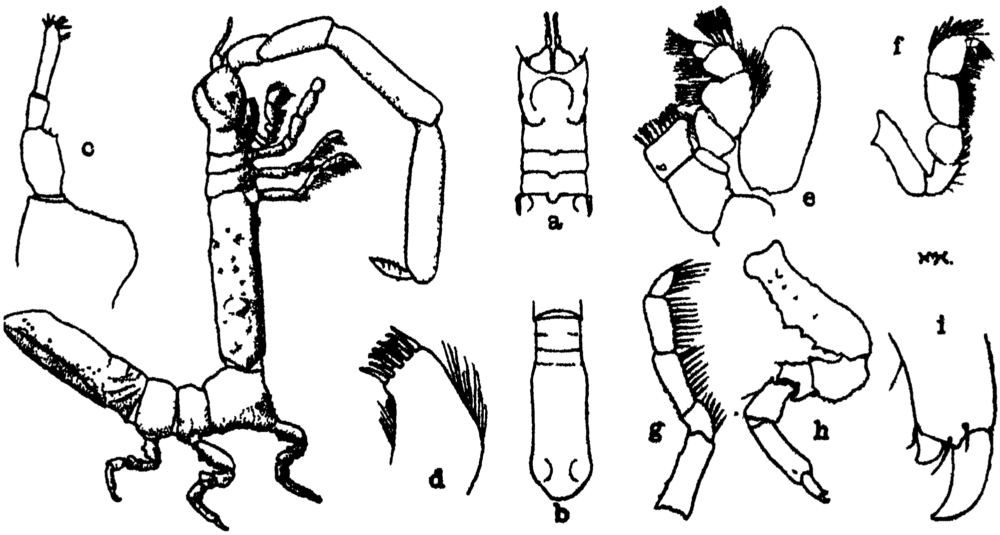


Fig. 1.

Parastacilla truculenta (4 diams.) *a*, Dorsal view of cephalon and first three peraeon segments (4½ diams.); *b*, dorsal view of pleon (4½ diams.); *c*, first antenna (20 diams.); *d*, outer lobe of first maxilla (40 diams.;) *e*, maxilliped (20 diams.); *f*, *g*, and *h*, first, fourth, and sixth peraeopods (10 diams.); *i*, terminal claws of fifth peraeopod (100 diams.).

palp not very elongate, composed of five articles; basipodite shorter than first three articles of palp together, the inner lobe short, not reaching to end of second article of palp and with a row of stiff, pinnate hairs on the almost straight distal margin; epipodite longer and wider than the palp. Peraeon cylindrical, the surface with some small and large scattered warts, and a few small conical spines. Anterior three segments each with a tubercle at middle of posterior margin. Infero-lateral margins of first reaching forwards almost to the level of the eye. Second and third segments subequal in length and fourth more than twice as long as first three together; fifth longer than sixth or seventh. First four pairs of peraeopods stout, flattened; first pair with curved, mostly pinnate or serrulate, marginal setae; second, third, and fourth pairs subequal in length, armed with strong, simple setae. Posterior three pairs prehensile, the last pair a little smaller than either of the others; basal joints armed with blunt, conical

spines; dactyli each with two strong, unequal, curved, apical claws, the smaller of which is less than one-third the length of its fellow. Pleon almost as long as fourth thoracic segment, obtusely-rounded apically; lateral margins tumid at the first third and again near posterior end; surface with small tubercles and a few larger protuberances; a dorsal swelling on each side near posterior marginal tumidities.

Colour, pinkish-brown with antennae and legs pale.

Length, 18·5 mm.

Hab.—South Australia: Beachport, 3-4 fms. (H. M. Hale). (Type, South Aust. Mus., Reg No. C237.)

This species was dredged up with a mass of weed and was found clinging to a plant of the same colour as itself; it was in the position shown in the figure, clinging to the weed with the three posterior pairs of peraeopods

Parastacilla bakeri, n. sp.

Fig 2

Cephalon subglobose, dorsally slightly and roundly elevated Eyes of moderate size First antennae reaching a little beyond termination of second article of second antennae; second article about one-fourth longer than third; flagellum rather broad, uniarticulate, more than twice as long as second and third

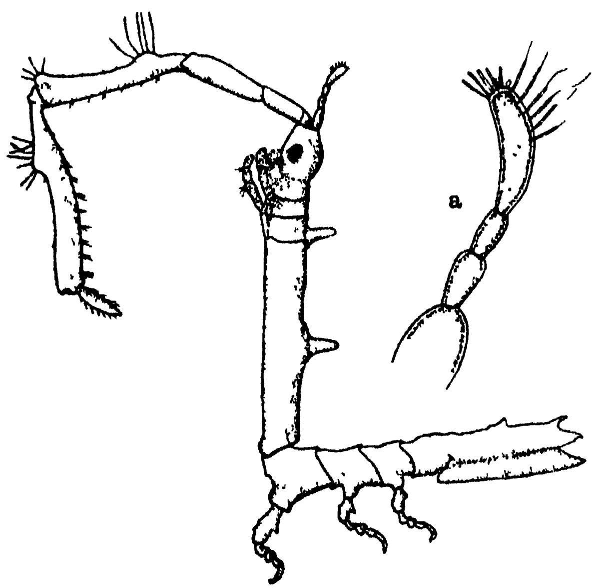


Fig. 2.

Parastacilla bakeri (9 diams.). *a*, First antenna (33 diams.).

peduncular joints together, and bearing sensory appendages on anterior half of margin. Second antennae large, stout; second article much shorter than third; fourth about one and two-third times as long as third, the dorsal margin elevated near posterior end and again at apex; fifth article one-third longer than fourth, the dorsal margin elevated at the first third of its length; each of the raised bosses is set with long hairs; flagellum short, one-fourth as long as fifth peduncular article. Fourth peraeon segment more than three times as long as first three together; dorsum of third segment with a large, blunt, spine-like projection; a similar projection at middle of length of fourth segment; fifth segment a little longer than sixth, which is longer than the seventh. Posterior three pairs of

peraeopods prehensile, the basos of each with a blunt spine and some smaller spines on inferior margin. Pleon considerably shorter than fourth thoracic segment; with a median, dorsal, conical projection just behind the middle of the length and with a backwardly-produced spine on each side of the mid-line near terminal end.

Length, 9·5 mm.

Hab.—South Australia: Marino Reef (W. H. Baker) (Type, South Aust Mus., Reg. No. C238.)

Mr. Baker remarks that he found this species some years ago on a "pinkish weed," and that the crustacean was of the same colour when alive; like the foregoing species it was clinging with the posterior thoracic appendages, and carried that part of the body above the geniculation in an erect position. Only a single specimen was taken and, as it is mounted in balsam, it is not possible to accurately figure the legs and other appendages. The anterior peraeopods are crowded together and have become stained; nevertheless, it can be seen that they are stout, as in *P. truculenta.* There is no articulation between the head and first free thoracic segment and the abdomen is unisegmentate.

NEASTACILLA, Tattersall.

Neastacilla, Tatt., "Terra Nova," Zool, iii, 1921, p 243

This genus was erected for the reception of *Astacilla falclandica,* Ohlin, and *A. magellanica,* Ohlin. A South Australian species is now added.

Type, *A. falclandica,* Ohlin.

Neastacilla algensis, n. sp.

Fig. 3.

♀. Form slender. Cephalon elongate, much longer than its greatest width; dorsum with a prominent, conical tubercle between eyes; anterior margin deeply and evenly excavate Eyes moderately large, subtriangular. First antennae reaching almost to posterior fourth of third article of second antennae; basal article stoutest; second stouter than third and equal to it in length; flagellum uniarticulate, with sensory appendages on distal half of margin. Second antennae

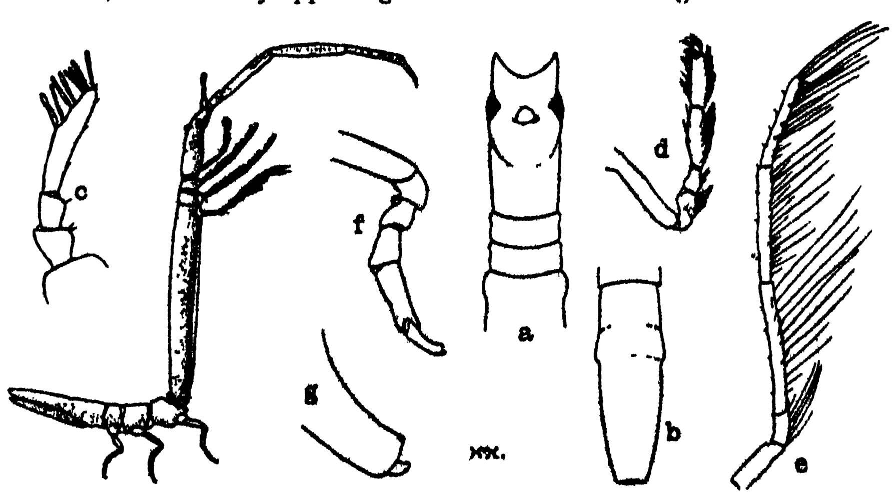


Fig. 3.

Neastacilla algensis (5 diams.). *a,* Dorsal view of cephalon and first three peraeon segments (10 diams.); *b,* dorsal view of pleon (10 diams.); *c,* first antenna (40 diams.); *d, e,* and *f,* first, fourth, and fifth peraeopods (20 diams.); *g,* terminal claws of fifth peraeopod (100 diams.).

subcylindrical, scarcely compressed; first article inconspicuous, not extending past anterior margin of head; second about half as long as head; third longer than fifth and very little shorter than fourth, which is longest; flagellum three-jointed, more than half as long as last article of peduncle. Palp of maxillipeds elongate, composed of five articles. Peraeon a little depressed, with a very obsolete, median, dorsal, longitudinal carina; surface almost smooth. First segment fused with the head; the infero-lateral margins forwardly produced but scarcely expanded downwards; second and third segments subequal in length, with antero-lateral angles prominent; fourth four times as long as first three together and five-twelfths of the total length of animal, exclusive of the antennae; fifth, sixth, and seventh segments decreasing in length backwards, the fifth being nearly twice as long as the seventh. Anterior four peraeopods slender; the first, and shortest, is furnished with fine fringing hairs and bears a flattened, subapical nail, which is serrate on the inner edge; second, third, and fourth appendages with long hairs on the inferior margins, and with the seventh joint represented by a slender nail; the second appendage is longer than the first and shorter than either third or fourth, which are subequal in length. Three posterior pairs somewhat feeble; dactylus of each with a small curved claw and a rudimentary second claw at apex. Pleon one-half as long as the fourth thoracic segment; unisegmentate with indications of two fused sutures, most distinct on sides; surface finely and sparsely punctate; lateral margins roundly prominent in the region of the second fused segment, thence a little curved and converging evenly to the truncate posterior margin.

Colour green, marked with tiny brown chromatophores; each uropod with a brown marking near base and another near apex. Thoracic appendages sub-hyaline.

Length, 12·25 mm.

Hab.—South Australia: Gulf St. Vincent, 6 miles west of Semaphore, 5-6 fms. (H. M. Hale). (Type, South Aust Mus., Reg. No. C239.)

A single specimen taken on *Cymodocea antarctica* during a recent dredging excursion of the Field Naturalists' Section. The very long and slender fourth thoracic segment at once separates *N. algensis* from its congeners.

Group II. IDOTEINEA.[3]

The species previously recorded from Australia are listed below:—

Idotea metallica, Bosc, 1802.
,, *baltica*, Pallas, 1772.
,, *brevicorna*, M. Edwards, 1840, ? = *I. baltica*.
,, *margaritacea*, Dana, 1853, ? = *I. metallica*.
,, *excavata*, Haswell, 1882, ? = *Paridotea ungulata*.
,, *caudacuta*, Haswell, 1882 = *Euidotea peronii*.
Euidotea peronii, M. Edwards, 1840.
,, *stricta*, Dana, 1853.
Paridotea ungulata, Pallas, 1772.
,, ,, var. *atrovirens*, Collinge, 1918.
,, (? *Euidotea*) *bakeri*, Collinge, 1917.
Crabyzos longicaudatus, S. Bate, 1863.
,, *elongatus*, Miers, 1876.

No specimens of *Idotea* were found amongst South Australian material, although both *I. baltica* and *I. metallica* have a wide range. *Paridotea ungulata* and *Euidotea peronii* (which are also widely distributed) are the commonest of the species occurring on reefs and in shallow water off our coasts.

(3) Cllnge., *loc. cit.*

Family IDOTEIDAE.

Key to Australian Genera.

a. Palp of maxillipeds four-jointed.
b. Pleon composed of three segments .. .. *Idotea*
bb. Pleon composed of not more than two segments .. .. .. *Euidotea*
aa. Palp of maxillipeds five-jointed.
c. Flagellum of second antennae well developed and multiarticulate.
d. Coxal plates coalesced with peraeon segments.
e. Palp of maxillipeds slender, with the fifth joint subequal in length to fourth; basipodite and epipodite small .. . *Crabysos*
ee. Palp of maxillipeds broad, with the fifth joint very much shorter than the fourth; basipodite and epipodite large .. *Synischia*
dd. Coxal plates free on second to seventh free peraeon segments.
f. Pleon composed of three segments .. . . *Pentidotea*
ff. Pleon composed of not more than two segments .. .. .. *Paridotea*
cc. Flagellum of second antennae very short, formed of only one to three articles . .. . *Zenobiana*

EUIDOTEA, Collinge.

Euidotea, Cllnge., Journ. Linn. Soc., Zool., xxxiv, 1918, p 84

Type, *Idotea peronii*, M. Edwards.

The diagnosis of *Euidotea* was based upon a single species. It now becomes necessary to somewhat enlarge the limitations of the genus, but it may be noted that similar specific variation occurs in other genera of the family.

Key to Species.

a. Coxal plates large, those of seventh peraeon segment extending back beyond hinder margin of segment.
b. Cephalon with a dorsal tubercle; peraeon longitudinally ridged . *bakeri*
bb. Cephalon not dorsally elevated; peraeon not longitudinally ridged .. *peronii*
aa Coxal plates small, those of seventh peraeon segment not nearly reaching to hinder margin of segment .. . . *stricta*

EUIDOTEA PERONII, M. Edwards.

Idotea peronii, M. Edw., Hist. Nat. Crust., iii., 1840, p. 133; Chilton, Trans. N. Z'd. Inst., xxii., 1890, p. 199 (part).
Idotea distincta, Guér. Méneville, Icon. Règne Anim., 1829-1844, Crust., p. 33.
Idotea caudacuta, Hasw., Proc. Linn. Soc N.S. Wales, vi., 1882, p. 181, pl. iv., fig. 4.
Paridotea peronii, Stebbing, Ann. S. Afr. Mus., vi., 1910, p. 433.
Euidotea peronii, Cllnge., *loc. cit* (syn.).
Fig. 4, *e*, *f*, and *g*.

Common on South Australian coasts. As noted by Haswell the colour is extremely variable; in large examples the body is very convex and the posterior coxal plates are subtriangular in shape.

Collinge describes the pleon as "composed of a single segment and three lateral sutures." In a not inconsiderable series of South Australian specimens, the first suture is complete, thus marking off a short basal segment just as in the example figured by Miers (4); the two segments are, however, not articulate. Chilton states that this suture is variable in *E. peronii* and *Paridotea ungulata*.

EUIDOTEA STRICTA, Dana.

Idotea stricta, Dana, U.S. Expl. Exped., xiv., Crust., ii., 1853, p 704, pl. xlvi., fig. 7; Miers, Journ. Linn. Soc., Zool., xvi., 1881, p. 62.
Idotea peronii, Chilton, Trans. N. Z'd. Inst., xxii., 1890, p. 199 (part).
Fig. 4, *a*, *b*, *c*, and *d*.

This species superficially resembles *E. peronii*, but a comparison of examples of both forms, of the same size and sex, shows that *E. stricta* differs in the following characters:—

(4) Miers, Journ. Linn. Soc., Zool., xvi., 1881, pl. ii., fig. 6.

Form more elongate. Dorsum of cephalon roundly elevated. Flagellum of second antennae composed of a lesser number of articles. Coxal plates small, none of them reaching to the posterior margins of the peraeon segments Pleon unisegmentate, with three pairs of short lateral sutures near base

Hab.—New South Wales (Dana); South Australia: Gulf St Vincent, 6-7 fms. (H. M. Hale), Kangaroo Island (W H. Baker)

Chilton regards *E. stricta* as "specimens of *I peronii* in which the two segments of the postabdomen have more or less completely coalesced" In describing *E. stricta*, however, Dana remarks: "Epimerals very small This narrow species has the epimerals occupying only part of the margin of each segment." In fig. 4 (*b* and *c*), a female of *E. peronii* 15 mm in length is drawn for comparison with an ovigerous female of *E. stricta* 15·5 mm in length, in larger examples the difference in the relative size of the coxal plates is more marked. Even in specimens of *E. peronii* 6 mm in length the last pair of coxal plates

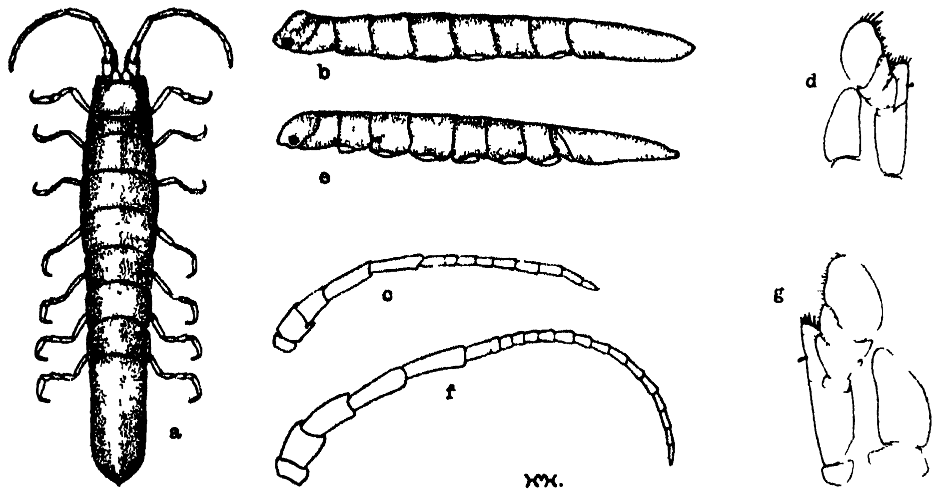


Fig 4

Euidotea stricta *a*, Dorsal view (3½ diams), *b*, lateral view (3½ diams) *c*, second antenna (5 diams), *d*, maxilliped (16 diams) *Euidotea peronii* *e*, lateral view (3½ diams); *f*, second antenna (5 diams), *g*, maxilliped (16 diams)

extend back to the level of the hinder margin of the segment, but in an example of *E. stricta* 20 mm. in length they do not nearly reach to the posterior margin. The type of the species is approximately 22 mm in length

EUIDOTEA BAKERI, Collinge

Paridotea bakeri, Cllnge, Journ. Zool. Research, ii, 1917, p 112 (? part), pl vi, figs 1-3 and 6-8

Fig. 5.

♂. Form moderately stout, four and one-half times as long as greatest width. Cephalon about twice as wide as long, narrower than the first peraeon segment, distinctly elevated dorsally and with a transverse groove near hinder margin; antero-lateral angles prominent; eyes of moderate size, situate dorso-laterally on slight elevations. First antennae reaching to middle of third peduncular article of second antennae; first article expanded; third about twice as long as second and subequal in length to the single-jointed flagellum Second antennae stout and rather short, reaching to posterior margin of fourth peraeon segment; first article short, well visible in dorsal view; second and third subequal

in length, each stouter than, and more than one-half as long as fourth and fifth, which are subequal in length; flagellum shorter than peduncle, composed of seven articles and a minute terminal style; first and ultimate articles subequal in length and longer than any of the others; second to penultimate gradually increasing in length. Outer lobe of first maxillae capped with ten strong spines, four of the innermost of which are denticulate; inner lobe with three setose spines. Maxillipeds broad and stout, with four-jointed palp. Basipodite as long as terminal segment of palp; inner lobe moderately wide, with strong spines at distal end Epipodite large, much longer than basipodite and first joint of palp together. Each peraeon segment strongly ridged on the longitudinal, median line, and with an oblique elevation, followed by a depression, midway between mid-line and lateral margins on each side. First segment a very little wider anteriorly than posteriorly; laterally forwardly produced to surround the posterior half of the head; anterior edges of lateral portions obliquely truncate; length at sides more than twice medial length. Second to sixth segments of equal length. First and seventh segments subequal in medial length, not much more than one-half as long as any of the others Coxal plates of second to seventh segments

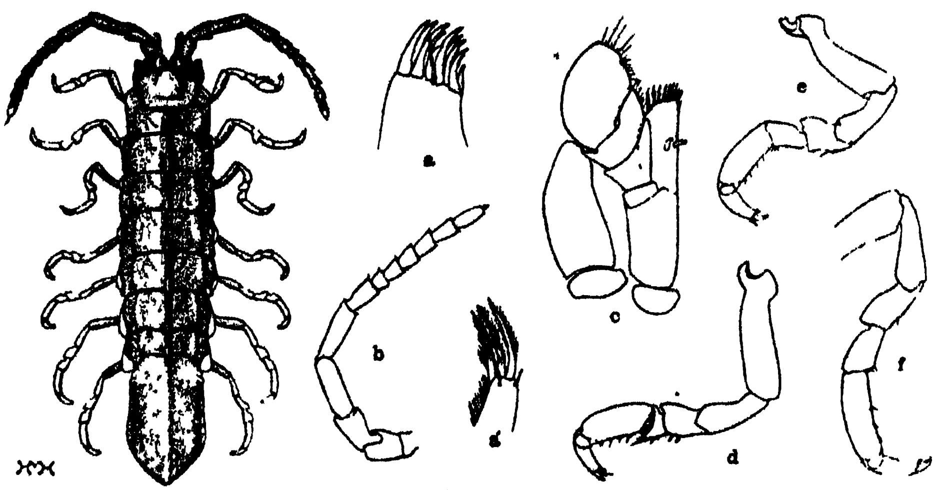


Fig 5

Eudotea bakeri (5 diams) *a*, Terminal part of outer lobe and *(á)* of inner lobe of first maxilla (60 diams); *b*, second antenna (8 diams.); *c*, maxilliped (32 diams), *d*, *e*, and *f*, first, fourth, and seventh peraeopods (16 diams)

conspicuous in dorsal view, none of them extending along the whole length of its segment; those of second to fourth small, rounded and placed in advance of the middle of the lateral margins of their segments; fifth to seventh increasing in size backwards; the fifth do not reach to the posterior margin of their segment; the sixth extend almost to the posterior margin; while the seventh pair are lobular, and reach back beyond the hinder edge of the segment. Anterior margin of each sternal segment with a row of rugose tubercles. Peraeopods slender. Pleon wide, with a longitudinal, median carina; unisegmentate, with three pairs of lateral sutures near base; lateral margins gently concave for anterior half, thence rounded and suddenly converging to the obtusely angular apex. Uropoda moderately elongate; endopodite narrowly and obliquely subtruncate at apex.

Colour pinkish-brown, with a black median stripe on peraeon; peraeopods yellowish, excepting on basos; antennae yellow on distal half of ultimate segment. Underside paler.

Length, 11 mm.

Hab.—South Australia: "Adelaide" (type loc.), Kangaroo Island, Marino Reef (H. M. Hale), Port Willunga Reef (S. S. Stokes).

An example 7 mm. in length is much darker in colouration, being almost black above and sooty beneath; in this specimen the flagellum of the second antennae consists of four articles and a terminal style. In the largest available male (21 mm.) the flagellum is eleven-jointed, and in a female of the same size is ten-jointed. The lateral sutures of the pleon are situated very close to the base, and the first, or anterior pair, is partly hidden by the posterior coxal plates.

As in *E. peronii*, the seventh coxal plates reach beyond the hinder angles of the last peraeon segment, but they are rounded and not apically angulate; the stouter maxillipeds and antennae, and the sculpture of the dorsal surface further distinguish *E. bakeri* from the last-named species.

I had previously described and figured this species in MS. as a new member of the genus *Euidotea*, not connecting it with *Paridotea*. Since the MS. was sent to press I received, through the courtesy of Dr. Collinge, the paper quoted above, and have made some tentative alterations in the nomenclature, but have let the descriptive details, as given above, stand. The specimens now described approximate very closely to Collinge's description of *Paridotea bakeri*, excepting as regards the maxillae and maxillipeds, which are very different; I venture to suggest that a re-examination of the type specimens may show that the mouth parts described for them belong to another species.

Crabyzos, Spence Bate.

Crabyzos, S. Bate, Proc. Zool. Soc., 1863, p. 504, Cllnge., Journ. Linn. Soc., Zool., xxxiv., 1918, p. 71

Type, *C. longicaudatus*, S. Bate.

In this well-defined genus the cephalon is usually partly fused with the first "free" peraeon segment. The coxal plates are coalesced in all the segments, and the coxopodites are well developed beneath, forming sockets in which the basos of the peraeopods articulates.

The form, at least in the male, is very elongate, and the mouth parts and uropods are correspondingly long and narrow. The terminal joint of the maxillipeds is relatively longer than in other genera of the family with five-jointed palp, while the basipodite and epipodite are small.

Collinge points out that *Idotea elongata*, Miers, should be referred to *Crabyzos;* this author[5] also mentions that he has examined two new species from South Australia, and promises a revision of the genus.

Key to Species.

a. Pleon acuminate at apex	*longicaudatus*
aa. Pleon incised at apex	*elongatus*

Crabyzos longicaudatus, Spence Bate.

Crabyzos longicaudatus, S. Bate, *loc. cit.*, p. 504, pl xli., fig. 7; Hasw., Cat. Austr. Crust., 1882, p. 278.

Idotea longicaudata, Miers, Journ. Linn. Soc., Zool., xvi., 1883, p. 63; Hasw., Proc. Linn. Soc. N.S. Wales, ix., 1885, p. 1001.

Fig. 6.

This species is moderately common amongst the "sea-grasses" growing in 3 to 6 fathoms in Gulf St. Vincent; the crustacean admirably matches the green leaves of the weed in colour.

Specimens before me differ from Spence Bate's figure in that the first antennae do not quite reach to the distal end of the third article of the second

(5) Cllnge., *loc. cit.*

antennae, and the first peraeopods are not markedly longer than the last pair. The first pair are long, and stouter than any of the others; the second to fourth

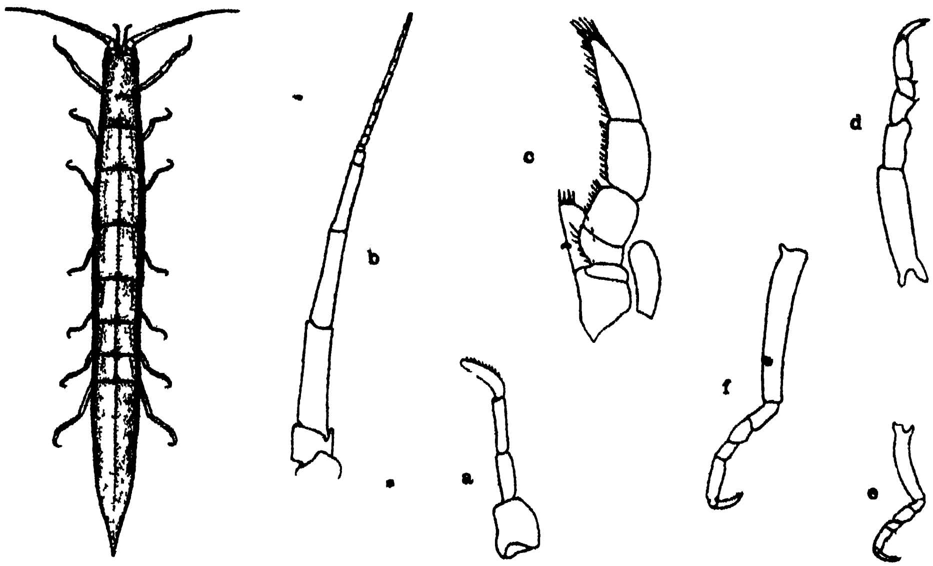


Fig 6

Crabysos longicaudatus (1½ diams) *a*, First antenna (8 diams); *b*, second antenna (5 diams), *c*, maxilliped (16 diams); *d* *e*, and *f*, first, fourth, and seventh peraeopods (5 diams)

decrease rapidly in size, the fourth pair being scarcely more than one-half as long as the first; the remaining pairs increase in length posteriorly In the seventh pair the basos is very long and the total length of these peraeopods is slightly greater than that of the first pair.

The dorsum of the peraeon is but slightly convex transversely, and the pleura form almost a right angle with the back The pleon is unisegmentate, with faint indications of two pairs of lateral sutures.

The example figured above is an ovigerous female 49 mm in length; in smaller specimens the peraeon is scarcely wider than the head, with the sides subparallel, and the pleon is more acuminate.

Hab.—South Australia: Gulf St. Vincent.

CRABYZOS ELONGATUS, Miers.

Idotea elongata, Miers, Ann. Mag. Nat. Hist. (4), xvii., 1876, p. 225, Chilton, Trans N Z'd Inst, xxii, 1889, p 198 (syn.).

Crabyzos elongatus, Clinge., Journ. Zool. Research, i, 1916, p 119

Hab.—New Zealand; South Australia (*fide* Collinge, *ut supra).*

Synischia, n. gen.

Form narrow, flattened. Flagellum of second antennae slender, multiarticulate. Maxillipeds stout, with five-jointed palp, the last joint small; basipodite and epipodite large Peraeon with a longitudinal, median ridge; all coxal plates perfectly fused with their segments. Pleon composed of a single segment, and with three pairs of short lateral sutures near base.

Type, *S. levidensis,* n. sp.

This genus differs from *Crabyzos* in the very different form of the maxillipeds, in the subhorizontal pleura of the peraeon segments and in having three pairs of distinct lateral sutures on the pleon.

Two other Idoteid genera, *Edotea,* Guérin Méneville and *Synidotea,* Harger, have the coxal plates perfectly united with the peraeon segments. Both of these genera differ from *Synischia* in having the palp of the maxillipeds three-jointed.

Synischia levidensis, n. sp.

Fig. 7.

♂. Form slender, six times longer than greatest width. Cephalon short and flat, not very convex dorsally; nearly twice as wide as medial length and distinctly narrower than the first peraeon segment; anterior margin concave; lateral margins slightly converging anteriorly. Eyes moderately large, situated dorso-laterally, and completely visible in dorsal view. First antennae reaching beyond second article of second antennae; basal joint expanded, longer than third, which is longer than the second, and subequal in length to the single-jointed flagellum. Second antennae slender, reaching back almost to posterior margin of fourth peraeon segment; first article short, visible in dorsal view; second and

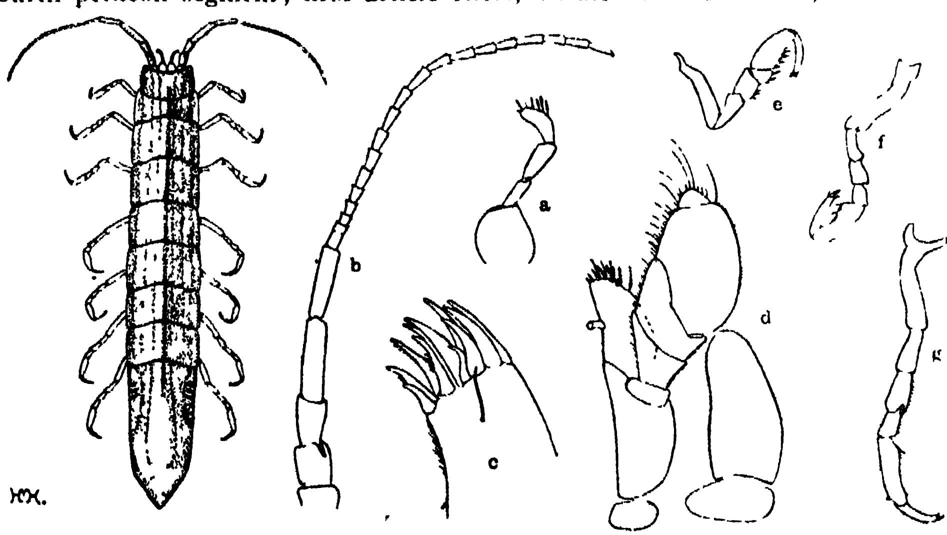


Fig. 7.

Synischia levidensis (3 diams.). *a,* First antenna (16 diams.), *b,* second antenna (8 diams.); *c,* terminal part of outer lobe of first maxilla (80 diams.); *d,* maxilliped (32 diams.); *e, f,* and *g,* first, fourth, and seventh peraeopods (8 diams.).

third subequal, together equal in length to fourth, which is longer than the fifth article; flagellum about one-half as long again as peduncle, composed of eighteen articles and a minute terminal style. Outer lobe of first maxilla capped with eleven strong spines, three of the innermost being denticulate. Maxillipeds broad, with five-jointed palp; basipodite stout, a little shorter than the epipodite; distal end of inner lobe with six strong, simple spines and some longer, slender, pinnate spines. Dorsum of peraeon roof-shaped, longitudinally medianly ridged, widest at last segment; first segment medianly short, distinctly less than half as long as second to fifth segments, which are equal in length; sixth and seventh of equal length, a little shorter than second to fifth segments. Coxal plates all fused with their segments, the junction being indicated by faint and indistinct depressions. Peraeopods rather feeble, increasing in length posteriorly, the first pair shortest. Pleon about as long as first four peraeon segments together, with a

longitudinal, median ridge on anterior fourth of its length, the remainder obsoletely carinate; composed of one segment, and with three pairs of lateral sutures; widest on anterior margin and with lateral margins slightly converging posteriorly for three-fourths of their length, thence suddenly converging to the acute apex. Uropoda narrow, with posterior margin truncate; endopodite apically narrowly rounded, subtruncate.

Colour very pale brown, speckled and longitudinally streaked with darker brown. Cephalon with a black, submarginal streak passing through each eye.

Length, 21 mm.

Hab.—South Australia: Gulf St. Vincent, 6 miles north-west of Outer Harbour, 6-7 fms (H. M. Hale). (Type, South Aust. Mus, Reg No. C242)

A single specimen dredged from amongst *Cymodocea.*

PENTIDOTEA, Richardson

Pentidotea, Richardson, Bull. U S Nat Mus, liv, 1905, p 368

Type, *Idotea resecata,* Stimpson.

Pentidotea australis, n. sp.

Fig 8.

♂ Form narrow, elongate, about six and one-half times as long as greatest width. Dorsum very convex. Surface smooth. Cephalon wider than long, much narrower than first peraeon segment; anterior margin almost straight in middle portion, very slightly convexly sinuate, laterally produced obliquely forwards to the angularly rounded antero-lateral angles. Eyes moderately large, well visible in dorsal view Peduncle of first antennae reaching to end of second

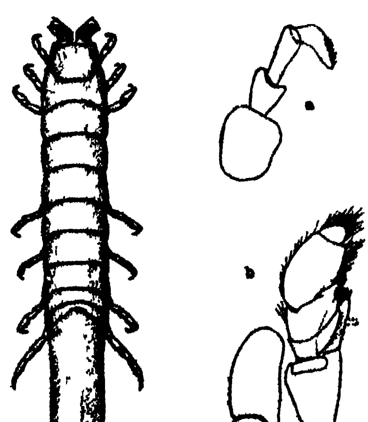


Fig. 8.
Pentidotea australis (1 1-10th diams.).
a, First antenna (6 diams.); *b*, maxilliped (6 diams.).

article of second antennae; first article large and dilated, a little longer than its greatest width; second article much wider and shorter than third, which is a little shorter than the first; flagellum subequal in length to last peduncular article. First article of peduncle of second antennae visible in dorsal view, one-half as long as second article, which is longer than the third; remainder missing. Maxillipeds with five-jointed palp; basipodite subequal in length to the epipodite inner lobe with some strong, simple spines at distal end. First peraeon

segment much narrower anteriorly than posteriorly, the lateral margins roundly converging; antero-lateral angles forwardly produced, surrounding the posterior part of the head to the level of the eyes; the medial length of this segment is much less than that of any of the others; second to sixth segments subequal in length; seventh a little shorter. Coxal plates in second and third segments elongate, less than half the length of the lateral margin; in the fourth about half the length of lateral margin; in the fifth, sixth, and seventh segments they are wider, slightly visible in dorsal view and almost as long as the lateral margins. Peraeopods strong, the anterior three pairs directed forwards, the others backwards; first pair stouter than second, third, or fourth, which are subequal in length; posterior three pairs successively increasing in size backwards, the seventh pair being one-third the length of the animal. Pleon as long as the first six peraeon segments together; first segment medianly longer than second; lateral margins of terminal segment subparallel for anterior two-thirds, thence narrowly converging to the subacute apex. Uropoda long and narrow; endopodite emarginate at apex.

Colour completely bleached after long preservation in alcohol

Length, 51 mm.

Hab.—South Australia: Kangaroo Island. (Type, South Aust. Mus., Reg. No. C234.)

A single, mutilated specimen with the mouth parts of one side missing. The narrow, elongate form is distinctive for this species, which somewhat superficially resembles *P. rotundata*, Rich., from Japan. In the last-named species, however, the eyes are very small, the head is scarcely narrower than the first thoracic segment, the maxillipeds are different, and the abdomen is less narrowed posteriorly.

PARIDOTEA, Stebbing.

Paridotea, Stebb., S. Afr. Crust., i., 1900, p. 52; Chilton, Subant. Is N Z'd, ii, 1909, p. 660; Barn., Ann. S. Afr. Mus., x., 1914, p. 424.

Type, *Idotea ungulata*, Pallas.

Key to Australian Species.

a. Third article of first antennae distinctly longer than second. Inner lobe of first maxillae capped with four setose spines. Anterior margin of endopodite of uropoda not, or scarcely, oblique	*ungulata*
aa. Second and third articles of first antennae subequal in length. Inner lobe of first maxillae capped with three setose spines. Anterior margin of endopodite of uropoda distinctly oblique .	*munda*

PARIDOTEA UNGULATA, Pallas.

Oniscus ungulatus, Pallas, Spicil. Zool., ix., 1772, p. 62, pl. iv, fig 11.
Idotea lalandii, M. Edw., Hist. Nat. Crust., iii., 1840, p 132, pl xxxi, fig. 7.
Idotea affinis, M. Edw., *loc. cit.*, p. 133.
Idotea edwardsii, Guér.-Méneville, *loc. cit.*, p. 33.
Idotea nitida, Heller, Verhandl. Zool-Bot. Ges. Wien, 1861, p 497.
? *Idotea excavata*, Hasw., *loc. cit.*, p. 182.
Paridotea ungulata, Stebb., *loc. cit.*, p. 53; Nierstrasz, Zool. Meded., iii., 1917, p. 113, figs.; Cllnge., Journ. Linn. Soc., Zool., xxxiv., 1918, p. 81 (syn.).

Fig. 9, *e* and *f*.

This widely distributed species is common in the shallow waters of South Australia.

Paridotea munda, n. sp.

Fig. 9, *a* to *d*.

♂. Form slender, more than five times longer than greatest width. Sides parallel, surface smooth and dull. Cephalon about one and three-fourths times wider than long, narrower than the first peraeon segment, evenly convex dorsally;

anterior margin sinuate, slightly incised medianly; antero-lateral angles not prominent; postero-lateral margins converging posteriorly; eyes moderately large, situate dorso-laterally, on slight elevations. First antennae reaching to middle of fourth peduncular article of second antennae; first article subglobose, longer than second or third (which are subequal in length), and as long as the single-jointed flagellum. Second antennae slender, reaching back to posterior margin of fourth peraeon segment; first article very short; second and third articles subequal in length, shorter than fourth and fifth, which are subequal in length; flagellum more than twice as long as peduncle, composed of twenty-two articles and a terminal style. Outer lobe of first maxilla narrow, capped with nine strong spines; inner lobe with three setose spines. Maxillipeds elongate, with five-jointed palp. Basipodite as long as the two terminal segments of palp together; inner lobe narrow, with slender spines at distal end. Third joint of palp forwardly produced at inner apex. Epipodite narrow, very slightly curved inwards apically; longer than the basipodite and first joint of palp together. First peraeon segment widest anteriorly, where the pleura are

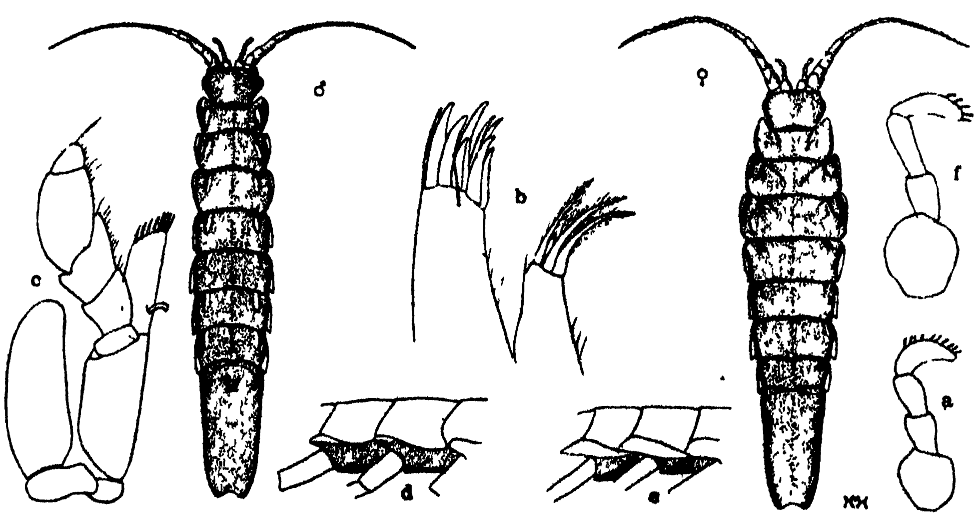


Fig. 9.

Paridotea munda, male (left) and female (right) (3½ diams.). *a*, First antenna (16 diams); *b*, first maxilla (80 diams.); *c*, maxilliped (32 diams.); *d*, lateral view of sixth and seventh peraeon segments (5 diams.). *Paridotea ungulata*. *e*, lateral view of sixth and seventh peraeon segments (4 diams.); *f*, first antenna (16 diams.).

produced outwards and forwards, but do not embrace base of head; anterior and posterior margins concave. Second to seventh segments subequal in length, the second and last a little shorter than the others. Second segment slightly, forwardly produced at anterior lateral angles, and with coxal plates occupying anterior half of lateral margins. Coxal plates of third segment rather more than one-half as long as lateral margins, of fourth almost as long as, of fifth equal in length to, and of last segment longer than, lateral margins. Peraeopods slender, without fur on inner margins. Pleon narrow, medial length about twice basal width; about one-half as long as peraeon; unisegmentate, with a very faint complete suture line near base, followed by two pairs of short, indistinct lateral sutures; gradually tapering from base to apex, which is evenly, concavely incised, with postero-lateral angles rounded. Uropoda narrow, posterior margin oblique; apex of endopodite truncate, a little concave.

Colour pinkish-brown, with a pale elongate spot, outlined in black, at each side of peraeon segments. A black streak extending from hinder edge of eye to base of cephalon. Antennae and peraeopods very pale yellowish, minutely dotted with brown. Uropoda with anterior half of inner margin bordered with black.

Length, 16 mm.

Ovigerous female. Second antennal flagellum composed of nineteen articles Second to fifth segments of peraeon widened, the third the widest; antero-lateral portions of second to fourth segments tumid.

Colour yellowish-green, with a blackish marking on each side of peraeon segments. A black streak behind eye. Marsupial plates with a conspicuous black spot at base.

Length, 14·5 mm.

Hab.—South Australia: Marino Reef (type loc., H. M. Hale), Port Willunga (S. S. Stokes); Tasmania (A. M. Lea). (Type male, Reg No C249, and allotype female, C250, in South Australian Museum.)

Females without ova are narrow in form, and in this sex the pleura of the first peraeon segment occasionally partly embrace the base of the head In a few specimens the pleon is much more deeply incised at the apex than in the type. The largest example available is 22 mm. in length.

This species may be separated from *P. ungulata* by the following characters:—The outer lobe of the first maxilla is narrower and is capped with a lesser number of spines, while the inner lobe bears only three setiferous spines; the epipodite of the maxillipeds is of different shape. The coxal plates, when viewed laterally (*cf.* fig. 9, *d* and *e*), are different, and the articles of the first antennae are of different proportions (fig. 9, *a* and *f*). In *P. ungulata* the apical notch of the pleon is broadly angulate or sinuate, with acute postero-lateral angles. *P. munda* is apparently allied to *P. fucicola*, Barn, from South Africa, but in the last-named species the fourth to seventh peraeopods have "thick fur on inner margin of fourth to sixth joints."[6] Barnard's figure shows that in *P. fucicola* the head is not narrower than the first peraeon segment and the terminal notch of the pleon is very small, while the mouth parts, which are figured by Collinge,[7] are somewhat different.

ZENOBIANA, Stebbing.

Zenobia, Risso, Hist. Nat. de l'Europe Mérid., v., 1826, p 110
Cleantis, Dana, Amer. Journ. Sci. and Arts (2), viii., 1849, p 427
Zenobiana, Stebbing, Ann. Mag. Nat. Hist. (6), xv., 1895, p. 24. Cllnge., Trans. Roy. Soc., Edinburgh, li., 1917, p. 749 (syn.).

Type, *Zenobia prismatica*, Risso.

Zenobiana phryganea, n. sp.

Fig. 10.

♂. Form narrow, elongate, nearly six times as long as greatest width, surface of head and thorax obscurely pitted and scratched; surface of abdomen with shallow but distinct pits. Width of cephalon one-half as long again as medial length; width at anterior margin equal to that at base; anterior margin slightly concave, posterior margin convex; eyes moderately large, situated dorsolaterally. First antennae stout, very short, extending a little beyond second

(6) Barn., Ann. S. Afr. Mus., x., 1914, p. 427, pl. xxxvi. E.

(7) Cllnge., *loc. cit.*, p. 84, pl. viii., figs. 30, 31.

article of second antennae; basal article stout, longer than wide; second and third subequal in length, together as long as the first; flagellum wide, apically rounded, longer than second or third peduncular articles. Second antennae short, not as long as head and first two thoracic segments together; first article small, and fifth a little longer than second or fourth, which are subequal in length; third article considerably shorter than second; flagellum composed of one article, tapering, scarcely longer than last article of peduncle. Maxillipeds moderately elongate, with five-jointed palp; basipodite scarcely longer than the first three articles of palp together, the inner lobe with some curved, pinnate spines at distal end; epipodite large, narrowed towards apex. Sides of peraeon parallel; first segment medianly the shortest, a little shorter than the second; fourth, fifth, and sixth segments subequal in length, longer than second, third, or seventh

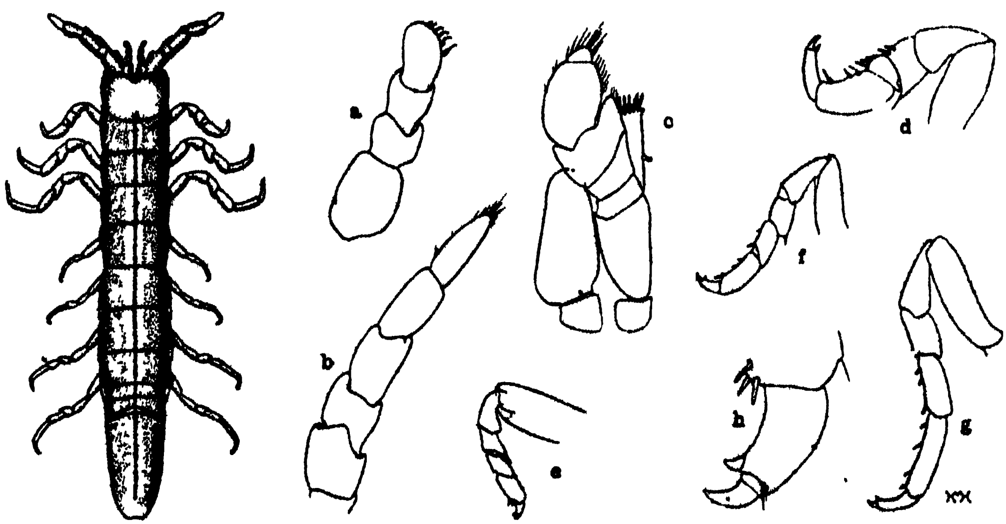


Fig. 10

Zenobiana phryganea (5 diams.). *a*, First antenna (30 diams); *b*, second antenna (15 diams); *c*, maxilliped (30 diams.); *d*, *e*, *f*, and *g*, first, fourth, fifth, and seventh peraeopods (15 diams); *h*, dactylus of fifth peraeopod (75 diams.).

segments. Coxal plates of second to fourth segments small, much shorter than the lateral margin of the segments; those of fifth to seventh larger and longer, extending back to well beyond posterior margins of the segments. Anterior three pairs of peraeopods stout, successively increasing in length backwards; last four pairs much more slender, increasing in length backwards, the fourth being much shorter than the first pair, and only about half the length of the seventh. Pleon composed of four segments and a single pair of short lateral grooves denoting a partly fused segment; first segment longer than second, which is twice as long as the very short third; terminal segment more than three times as long as first three segments together; lateral margins slightly converging for anterior half, thence roundly converging to the somewhat narrow apex, which is emarginate. Uropoda narrow; endopodite apically rounded, subacute.

Colour brown, with indistinct paler vermiculations; a median, longitudinal line on peraeon and greater part of length of pleon, and lateral edges of thoracic segments, sooty; a pale stripe on each side of mid-line of peraeon. Coxal plates, legs, apex of abdomen, and flagellum of both first and second antennae pale yellow. Underside pale brown. Uropoda yellow, with brown markings.

Length, 11 mm.

Hab.—South Australia: Marino Reef (W. H. Baker and H M Hale) (Type, South Aust. Mus., Reg. No. C235.)

In a specimen 8 mm. in length the abdomen is relatively less narrowed posteriorly

This species approaches *Z granulosa*, Heller, and *Z tubicola* Thomson, in that the extremity of the abdomen is notched *Z granulosa*, however, has five pleon segments, and *Z. tubicola* apparently has but three [8] *Z phryganea* differs in the much shorter antennae and four-segmented pleon

The South Australian specimens were found in short, hollow pieces of the stem of a marine plant, broken at one end just below a node, thus forming a tube with one end closed; the habit of this Isopod, and of a small Amphipod which was taken at the same time, recalls to mind some of our Caddis worms, which utilise, quite similarly, portions of plant stems It is possibly owing to this method of concealment that the genus has not previously been noted in Australia.

(8) Chilton, Trans N Z'd Inst, xxii, 1890, p 203

THE RELATIONS BETWEEN DISTRIBUTION, STRUCTURE, AND TRANSPIRATION OF ARID SOUTH AUSTRALIAN PLANTS.

By J. G. Wood, B.Sc., Department of Botany, University of Adelaide

[Read September 11, 1924.]

In an earlier paper (11), the author showed the effect of structural modifications on the transpiration rates of the chlorophyllous organs of several arid Australian plants. This paper embodies the result of further work on transpiration, the plants selected coming from more definitely xerophytic, and from more sharply defined habitats than those previously described.

Physical Environment.

The experiments were carried out at Curnamona, a sheep station about 250 miles north-east from Adelaide and 45 miles south of Lake Frome. Curnamona is situated near the centre of a great plain which stretches from a spur of the Flinders Range traversed by the railway line to Broken Hill at the south to Lake Frome at the north. The plain is bounded by the Flinders Range on the western side.

As one proceeds northwards the environment becomes progressively more arid. The average annual rainfall at Koonamore, at the south of the plain, is 8·46 inches, at Curnamona it is 7·03 inches, and at Frome Downs, near Lake Frome, it is 5·76 inches. The aridity of the enviroment is still further increased by the action of wind and of insolation. A general survey of the ecology of this district has already been published (7). In this paper, climatic data and also the analyses of numerous soil samples taken in this area were given. It was pointed out that in this region there was no striking variation in physiographic features, and little abrupt discontinuity in climatic factors.

Under such conditions edaphic factors are of great importance in determining the distribution of the vegetation, and Osborn and Wood *(loc. cit.)* showed the significance of such factors in the distribution of several halophytic and non-halophytic communities.

This paper deals with the water relations of the plants as effecting distribution.

Methods.

The methods of measuring the rate of transpiration and the various climatic factors were the same as those already described in the paper previously cited.

Comparsion of the curves previously given for the evaporation, temperature, and light intensity at Dilkera with those at Curnamona given here show higher values throughout in the latter case.

Structure and Distribution of the Plants.

The plants used were *Kochia planifolia* (bluebush), *Acacia aneura* (mulga), *Eremophila glabra* (tarbush), *Acacia Victoriae* (=*A. sentis*, prickly acacia), *Loranthus quandang* (grey mistletoe), and *Senecio magnificus*.

Of these plants *Kochia planifolia*, *Acacia aneura*, and *Eremophila glabra* are the character plants over the level plain. *Kochia* is the most frequent, and its blue-grey foliage gives a very characteristic facies to the plain. *Eremophila glabra* and *Acacia anuera* are more local. The bluebush usually forms a very

pure community, but in places *Atriplex vesicarium* is associated with it. Analyses of the soils from the plain (7) showed that the water-retaining capacity at saturation, and also the percentage of soluble salts were lower than in soils characteristic of *Atriplex vesicarium* communities. From these data the opinion was expressed that the bluebush community was of a more xerophytic type than the saltbush *(i.e., Atriplex vesicarium)* which is replaced by the bluebush as one proceeds northwards (7). Transpiration experiments confirm the contention that increased aridity of the environment is the factor determining the distribution.

Kochia planifolia, F. v. M.

This bluebush forms rounded shrubs from one-half to one metre in height. The bushes are freely branched and bear numerous subcylindrical leaves with a constricted base. The leaves are from one to two centimetres long and are covered with a thick felt of hairs. The leaf is succulent and has a similar structure to that described for *Kochia sedifolia* (11).

The epidermis of the leaf is uncutinised with simple stomates The chlorenchyma is peripheral and the water storage tissue central. As in *K sedifolia,* the chief interest lies in the hairs. Each hair has a branched stellate structure as figured (fig. 1). The presence of living protoplasm in the stalk cells makes it probable that the hairs have a water-absorbing function. The hairs form a thickly woven felt over the surface of the leaves.

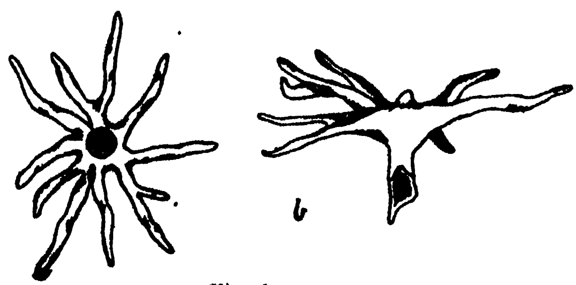
a  b

Fig 1.
Stellate hairs of *Kochia planifolia*
a, Viewed from below. *b*, Side view ×281.

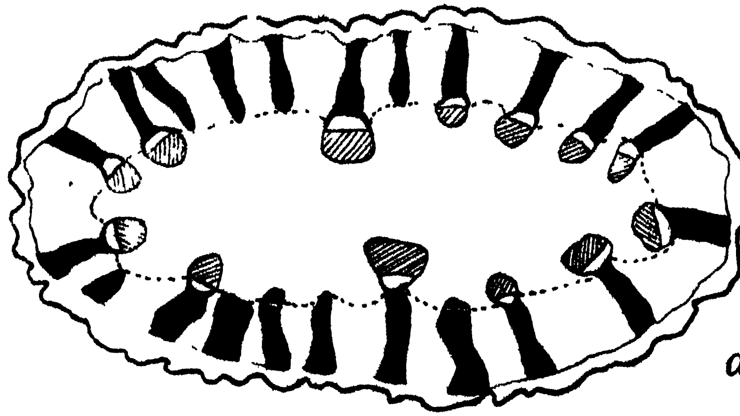
Acacia aneura, F. v. M.

In this district, the mulga is a tree with a characteristic canopy-topped habit, and is limited to groves where the soil is slightly more sandy than that of most of the terrain. The phyllodes, about 10 centimetres long and 2 centimetres wide, are narrow and not of the "broad-leaved" type. The structure of the phyllode is essentially like that of *A. linophylla* which Cannon (2) figures. A diagram of *A. aneura* is given here for comparative purposes (fig. 2). The outer margin of the section is crenulate, but not regularly marked into furrows and ridges. The stomates occur in the depressions and the guard cells have a cutin collar as shown. The whole epidermis is covered with small cellular trichomes.

Eremophila glabra, (R. Br.) Ostenf.

This plant grows as a tall shrub or small tree in isolated thickets. The leaves are crowded in condensed shoots at the ends of the branches. The structure of the leaf is shown in fig. 3. The leaf is iso-bilateral, stomates and hairs being developed on both sides. The epidermis is cutinised; the guard cells of the stomates have subsidiary cells and the cuticle of the epidermal cells projects as long papillae forming collar-like ridges.

Two types of hairs are developed on the epidermis—ordinary covering hairs which are multicellular and uniseriate, and glandular hairs. The latter are sunken in the epidermis in the old leaf, but this is a secondary development (3). The glandular hairs are of the capitate type, and are differentiated into basal, stalk, and head regions. The basal cell is large and is imbedded in two subsidiary cells, which, like the basal cell, have densely granular contents. The stalk is unicellular The divisions in the head are all vertical and are formed in a radial manner, giving the type of subspherical shield of eight radiating cells figured by Miss Collins (3) for *E. latifolia* In addition to the glandular hairs shizogenous secretory cavities are developed in the mesophyll.



a.

b

Fig. 2.

a, Diagram of transverse section of phyllode of *Acacia aneura*. Sclerenchyma, black; xylem, shaded; inner wall of epidermis indicated by unbroken line; inner limit of chlorenchyma indicated by broken line. Water storage tissue central ×47.
b, Furrow of phyllode, showing thick cuticle, stomate and collapsed hair. ×249.

The chlorenchyma is not continuous under the upper and lower epidermes of the leaf, but alternates with larger cells containing no chloroplasts but with watery contents and frequently with crystals of calcium oxalate. These cells usually occur beneath the glandular hairs, the chlorenchymatous cells beneath the stomates. The empty cells appear to be comparable to the hypodermal layer in such genera as *Atriplex*, and to have a water-storing function. The veins are simple with little mechanical tissue developed.

Acacia Victoriae, Benth.

This tree grows in a different habitat from the above three plants. It is limited to watercourses and swamps where there is a permanent water table. The phyllode structure is similar to that found in several Central Australian

species of *Acacia* of this type. The phyllode is strictly bi-facial, double bundles often occurring. Fig 4 illustrates the general structure The centre of the leaf is occupied by water-storage tissue, the cells being parenchymatous and containing

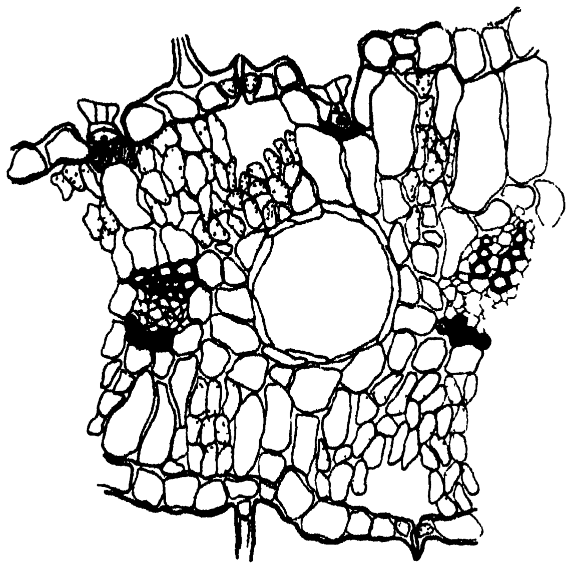


Fig 3
Transverse section of leaf of *Eremophila glabra* ×93

great quantities of tannin. This is shown black in the figure The rest of the phyllode is occupied by chlorenchyma, the cells being palisade-like with few air spaces between them. The stomates are not depressed No trichomes are developed on the epidermis, but the latter is fairly heavily cutinised

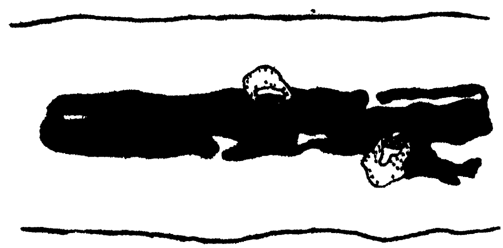


Fig. 4.
Diagram of transverse section of phyllode of *Acacia Victoriae*. Chlorenchyma colourless water-storage tissue containing tannin central Xylem shaded, sclerenchyma dotted ×31

Senecio magnificus, F. v. M.

This is an erect glabrous perennial with large glaucous leaves from four to six centimetres long and about two centimetres wide. The stem is almost herbaceous. The leaves are ovate-lanceolate and coarsely toothed. The plant is found only near a copious water supply, usually in sandy soil.

The leaf structure shows it to be of a mesophytic type. The epidermis is thinly cutinised. The stomates are small but in no way protected. The leaf is

bi-facial, the mesophyll consisting throughout of loosely packed, palisade-like chlorenchymatous cells (fig. 5).

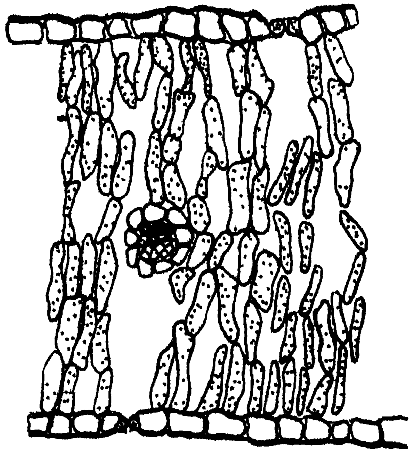


Fig. 5.
Transverse section of leaf of *Senecio magnificus*.
×47.

Loranthus quandang, Lindl.

Loranthus quandang is parasitic upon the branches of *Acacia aneura*. The leaves are usually three to four centimetres long and two centimetres wide. They are covered with a dense tomentum of stellate hairs with a single stalk cell. They are developed in great numbers over the epidermis. The stomates are large and each guard cell has a subsidiary cell. The leaf is not differentiated

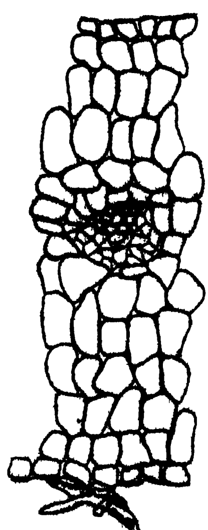


Fig. 6.
Transverse section of the leaf of *Loranthus quandang*.
×93.

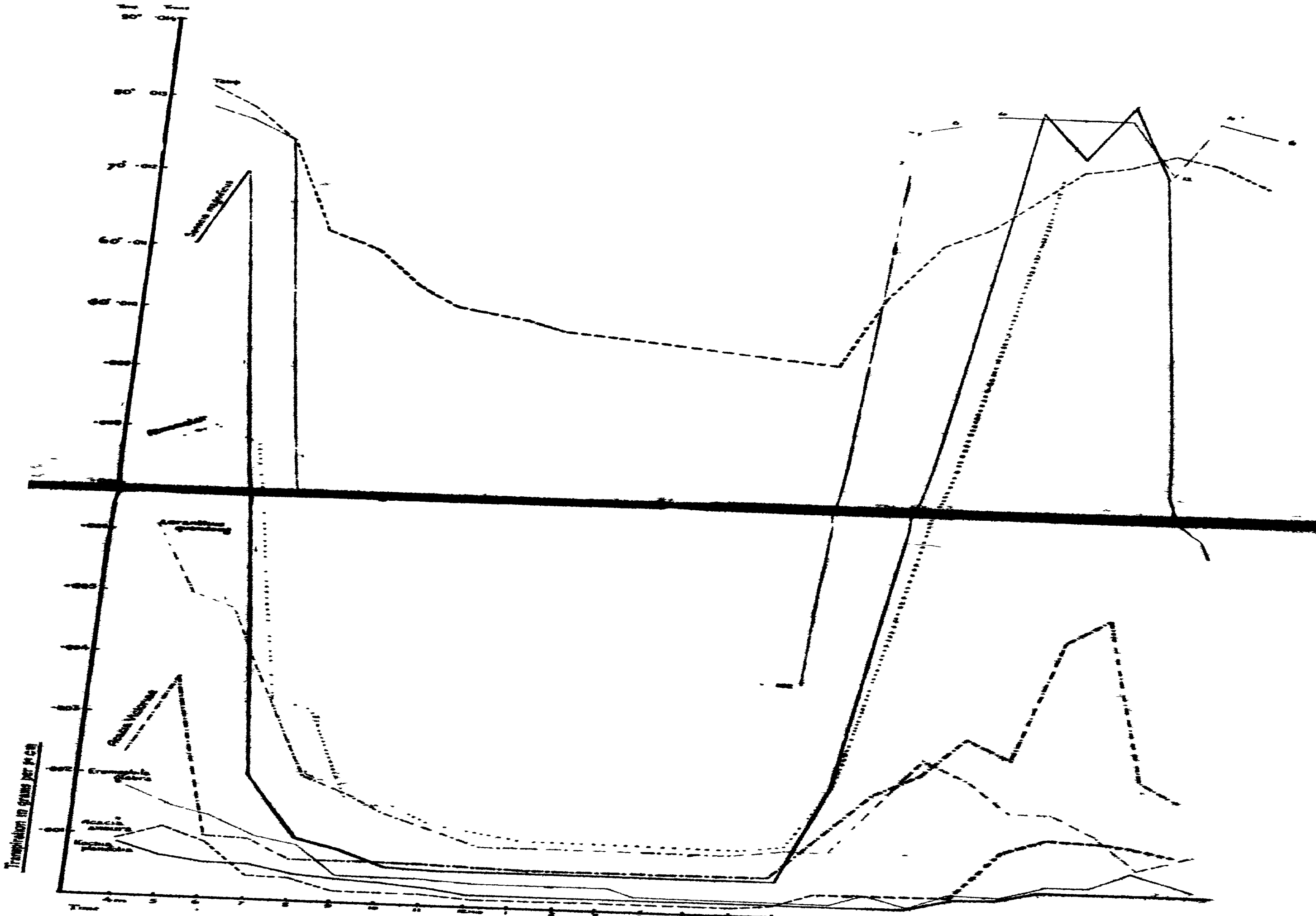


Fig. 7.

Curves for transpiration and various external factors. Amount as ordinate and time as abscissa in each case. The atmometer curve is compressed from 12 noon to 4 p.m. The actual readings are given in Table I.

to a great extent. The mesophyll cells are approximately isodiametric; closely packed together with few air spaces, and contain very little chlorophyll. There is no mechanical tissue apart from the xylem. Many of the cells have a refringent, ring-like body containing a cluster of crystals in the centre. Their chemical nature is not at present clear.

TRANSPIRATION.

Analysis of the transpiration curves shows, in the first instance, that external conditions are the most important factors influencing the rate of transpiration. The transpiration curve is of the same general type as that for the evaporating power of the air. *Kochia planifolia* has an almost flat curve similar to that of *K. sedifolia* described before (11), and illustrates the efficient insulating effect of the thick covering of hairs. The actual readings for the transpiration rate and for the physical factors are given in the following table. It will be seen that temperature, evaporating power, and light intensity are much greater than they were at Dilkera, and consequently the transpiration rate during the day is slightly higher, but is not proportionately greater. The curve for the evaporating power of the air is one-tenth the scale of the transpiration curves. All transpiration and evaporation figures are in milligrams per square centimetre per hour.

The plants from the different habitats show markedly different transpiration rates. Those from the plains *(Kochia planifolia, Acacia aneura,* and *Eremophila glabra)* have analogous curves for the transpiration rate plotted against time, and also the numerical values for the rates of water-loss per square centimetre per hour vary less than a milligram from one another. *Kochia planifolia*, however, is more definitely arid. One concludes that these plants of the plains are in a stable state of balance with their environment. It is an interesting case of the response of plant organisms to the complex of stimuli of an arid environment along separate structural lines. In spite of the anatomical differences the plants converge in having their rates of transpiration reduced to an approximately constant common level. It should be noted, however, that *Kochia* is the dominant plant, and that *Acacia aneura* and *Eremophila glabra* are local.

Acacia Victoriae shows a higher transpiration rate than the above three plants, as might be expected from its habitat The amount of water lost is still small, however, and lies within the range of that lost by several plants investigated in the Arizona deserts (4, 9).

Senecio magnificus is typically mesophytic. Such lavish transpiration would not be possible in any other habitat but one with a constant water supply. The approximation in form of the transpiration rate curve for this plant to that for the evaporating power of the air will be evident from fig. 7.

Loranthus quandang is of special interest, as it is parasitic upon the mulga. The plant is lavish in its transpiration of water when compared with the other plants with which it is associated. Its transpiration is greatly in excess of that of its host. In this case the correlation between transpiration and absorption of soil water is not so essential. The mistletoe has all the water stores of the mulga to draw upon. It is well known that plants which obtain water and dissolved substances from the bodies of other living organisms have higher osmotic pressures than have their hosts, and it is interesting to find that the transpiration rate (at least in *Loranthus quandang)* is also much higher. The increased supply of water and mineral nutrients to the mistletoe as compared to shoots of its host will be obvious. It is very rare to find a specimen of *Acacia aneura* that has not several plants of the mistletoe upon it, and its success in this region is probably due in no small measure to the above two physiological factors together with its condition of parasitism.

TABLE I

Plant, etc.	3·0 p m	4·0	5·0	6 0	7 0	8·0	9·0	10·0	11·0	7 0 a.m	8·0	9·0	10·0	11·0	12·0	1·0 p m	2 0	3·0	4·0	Leaf Area sq cms.
Eremophila glabra	—	1·77	1 55	1·33	1·11	88	44	44	44	2·88	·22	44	·22	44	44	·66	66	88	66	225 0
Kochia planifolia	—	·86	·69	·60	·57	·43	·35	·35	29	1·14	·14	14	14	35	35	50	50	·50	·50	700 0
Loranthus quandang	—	6 17	5·00	4 74	3·23	2·06	1·76	1·46	·58	7·64	1·16	1 76	2·64	2 32	2·06	—	1 46	88	1·16	171 4
Senecio magnificus	—	11·08	12·24	7·24	2 07	1·03	·86	·69	·69	4 83	2·07	6 20	10 17	13 62	12 93	13 80	12 58	7·41	6·03	288 8
Acacia aneura	—	·96	1·15	·96	·38	·38	·19	19	19	1·77	·19	38	38	·38	1 15	1 34	1 34	1 15	1·15	259 4
Acacia senilis	—	2·33	3·66	1·00	1·00	·66	·66	·66	·66	4·00	1·33	2 00	2 33	3·00	2·66	4·66	5 32	2 33	2 00	152·8
Atmometer	—	77·0	80 5	77·5	33·0	31·0	16 0	16·0	13.0	73·0	22·0	41 5	71 5	114·0	162·0	213 0	202·0	190 5	188·0	—
Light	4	7	12	Set	—	—	—	—	—	102	12	7	6	4	4	4	12	4	6	—
Temperature, °F.	83·0	81·5	78·0	63 0	60·0	54 5	51 5	50·0	48 0	44·0	55 5	64 0	67 0	72·0	77·0	78·0	80 0	79·0	75 0	—

Discussion and Conclusions.

In any plant, its photosynthetic and respiratory activities necessitate a movement of water, and this occurs from the root or other absorbing organ through the various tissues to the stomates of the transpiring organ. The relation of a plant organism to the water supply and to the evaporating power of the air is the most important factor controlling the distribution and habitat of the plant organism.

In arid regions, a plentiful supply of water is limited to a few months, or it may be a few weeks of the year, and reduction of the amount of water lost by transpiration will be a necessary feature of any plant which is to survive under such conditions. Both water absorption and transpiration are greatly influenced by three factors—external or climatic, morphological, and physiological conditions. In a previous communication (11) the connection between transpiration and leaf structure was traced. There was shown the relative efficiency in the reduction of water-loss by such morphological modifications as heavily cutinised epidermes, collars around stomates, development of oil glands and of trichomes. Also the efficiency of these structures in protecting the stomates from external influences was considered. This paper broadens the scope of the investigations and considers the habitat.

In the mesophytic plants like *Senecio* abundant transpiration occurs; in *Acacia Victoriae* there is a lessening of transpiration due to a heavier cutinisation of the epidermis, and in *Acacia aneura* and *Eremophila glabra* the structural modifications become intensified. These plants form a graded series, not only as regards habitat, which is progressively becoming drier, but as regards modifications of structure and amount of water lost by transpiration. *Atriplex vesicarium*, the saltbush, and particularly *Kochia*, the bluebushes, are the character plants over the terrain. In these plants is reached the climax, as it were, in water conservation.

A consideration of the floras of the arid regions of the world shows that the growth forms can be divided into three groups:—

(*a*) Succulents.
(*b*) Indurated microphylls
(*c*) Tomentose microphylls.

The indurated microphylls include all spinescent and phyllodic forms. Plants belonging to this group examined in Central Australia include *Acacia aneura*, *Acacia Victoriae*, and *Eremophila glabra*, and also *Geijera parviflora*, *Pholidia scoparia*, and *Casuarina lepidophloia*, in a previous paper (11). All these plants are woody and have reduced leaves, thickened cuticles, sunken stomates, or similar xerophytic characteristics. Such modifications, however, are not only characteristic of arid regions, but of any region where the evaporation is markedly in excess of the rainfall, as, for example, in the sclerophyll forests of the Mount Lofty Ranges near Adelaide (1), where the rainfall varies from 20 to over 40 inches, and yet similar modifications are to be seen. The degree of protection is more pronounced in the drier regions, as Curnamona, but it does not differ in kind. The reduction of leaf surface and heavier cutinisation is, in fact, similar to that shown by plants from moist climates (*i.e.*, mesophytes) which are grown under arid conditions (4, 8). These developments are purely the response of the plant organism to the complex of stimuli which makes the environment arid, that is, increased insolation, increased temperature, decreased relative humidity, and decreased water supply. Such modifications as are possessed by these indurated plants must, it seems, be considered as inherited variations, and as the more primitive response to arid conditions. The woody stems of these plants doubtless act as reservoirs of water in many forms.

Succulent plants as the Cactaceae, Crassulaceae, Euphorbiaceae, and so on, give a distinct facies to many arid regions. They dominate the deserts of Arizona and Texas, portions of the deserts of South America, and in the Karroo and parts of Namaqualand in South Africa. In these plants the amount of transpiration is markedly less than the absorption during the wet season, and large amounts of water are stored in the parenchymatous and tracheidal tissues of the stem or leaf. So efficient are these storage organs that many Cactaceae will withstand a prolonged period of desiccation of three years under experimental conditions (6). Such forms, as MacDougall (6) has pointed out, show evidently a secondary and more highly specialized condition of xerophytism.

One other growth form remains for consideration, the tomentose microphylls. These are all perennial shrubby plants and include in Australia saltbushes (*Atriplex* spp.), bluebushes (*Kochia* spp.), and certain species of *Rhagodia*. Sagebushes (*Artemisia* spp.) are the dominant plants in the Great Basin Desert of North America; and the Karroo bush (*Pentzia*) is dominant in the Upper Karroo of South Africa. These plants have all a dense tomentum of hairs over the epidermis. They are characteristic of the drier portions of the various arid regions mentioned, and their success appears to be due to the efficiency of the hairs in reducing transpiration and also to the development of efficient absorbing organs, either by an extensive root system or by other means. It has been shown that the Central Australian species have a very low rate of transpiration. Further unpublished observations by the writer show that some plants from arid Australia are capable of absorbing water from the air through their leaves. MacDougall has shown that the sagebush, *Artemisia tridentata*, has a transpiration rate practically identical with that of *Atriplex vesicarium*, *viz.*, of 0·4 milligrams per square centimetre per hour (5), and at the same time an extensive root system is developed (10). These tomentose forms, too, we must consider as secondary and not as primary forms in response to arid conditions.

Transpiration studies, it will be seen, when taken in conjunction with the soil-water relations of the plant, give a very valuable insight into the determination of the distribution and of the habitats of desert plants. As regards Australian habitats, it shows clearly the reasons for the dominance of individual species in particular localities.

In conclusion, I wish to thank Professor T. G. B. Osborn for help throughout this work; and also the Managing Director (A. G. Rymill, Esq.) of the Canowie Pastoral Company, owners of Curnamona, and also their manager (Mr. L. Boothby, of Curnamona).

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AUSTRALIAN FUNGI: NOTES AND DESCRIPTIONS.

No. 5.

By J. BURTON CLELAND, M.D.

[Read October 9, 1924.]

This paper is a further contribution to the records of the larger Australian fungi and includes descriptions of additional new species. As the authors (Cleland and Cheel) of this series are now located in different States, they propose contributing the papers independently of each other, unless special collaboration has occurred. Our previous papers have appeared in these Proceedings as follows:—No. 1, xlii., 1918, p. 88; No. 2, xliii., 1919, p. 11.; No. 3, xliii., 1919, p. 262; and No. 4, xlvii., 1923, p. 58. Where a species has been previously dealt with by us, the reference is given in brackets (*e.g.*, iii., 90). Where colour tints are specifically noted in capital letters, they are based on Ridgway's "Colour Standards and Colour Nomenclature," unless Dauthenay's "Repertoire de Couleurs" is specially indicated. We would again like to state how much we owe to Mr. C. G. Lloyd for identifying specimens for us, and to thank those in Australia who have aided us by sending us fungi that they have collected.

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WHITE-SPORED AGARICACEAE

AMANITA.

382 (iii., 90). *Amanita grossa*, Berk. N.S. Wales: Kendall, March; North Bridge, Sydney, April. South Australia: Mount Lofty, March, July, spores subspherical, 9·3 to 11×7·5 μ, 8 to 9 μ.

383. *Amanita ochrophylla* (Cke. and Mass.) We have previously referred these Australian plants to *Amanita strobiliformis*, Vittad (Agric. Gaz., N.S. Wales, xxv., Dec., 1914, p. 1045), sinking *Lepiota ochrophylla*, Cke and Mass., as a synonym. Now we have come to the conclusion that the specific name *ochrophylla* should stand, and that the species is best placed under *Amanita*. N.S. Wales: Neutral Bay, Jan.; Narrabeen, March. Victoria: Near Ararat in sandy soil, up to 10 cm. in diameter, E. J. Semmens, No. 1 South Australia: Two small specimens, collected by Prof. Howchin in sandy scrub near the coast, Hundred of Waitpinga, Encounter Bay, in 1909, appear to be this species, spores 10·5 to 11·5×6 μ. Typical specimens were found at Mount Lofty in April, 1924, after early autumnal rains and mild weather; smell strong, pileus scaly and near Pinkish Buff (xxix.), the stems usually the same colour but sometimes tinted with Light Vinaceous Cinnamon (xxix.), gills becoming Buff Yellow (iv.), cut surface sometimes tinted with Vinaceous Russet (xxviii.), spores white and subspherical, 7·5 μ, 9×7·5 μ.

384. *Amanita muscaria*, (L.) Fr. Cke., Hand. Austr. Fungi, No. 7 (Vict.). South Australia: Under oak and spruce, Aldgate, March, 1924 (Dr. M. Scott and Mrs. Barclay), typical and very handsome specimens, some partly eaten by slugs or other animals.

385. *Amanita rubescens*, (Pers.) Fr. South Australia: Under chestnuts, Mount Lofty (near the summit), March and April, 1924, spores subspherical to elliptical, 9·3×6·5 μ, 7·5 μ. These specimens are typical, the only difference noted from Carleton Rea's description in British Basidiomycetae is in the patches on the pileus being membraneous-warty rather than mealy.

AMANITOPSIS.

386. *Amanitopsis vaginata*, (Bull.) Roze. Cke., Hand. Austr. Fungi, No. 11 (Q'land, N.S. Wales, Vict.). N.S. Wales: Neutral Bay, Feb., March; Kendall, Dec. In Sydney specimens, undated, the spores were thick-walled, spherical,

10·4 to 13·8 μ; the following colours were noted: periphery of the pileus Chocolate (Dauthenay, pl. 343, ton 1), darker towards the centre (tons 2 and 3), and in another plant near Pale Otter Brown (pl. 354, ton 1), paler than Loutre

Lepiota.

387. *Lepiota procera*, (Scop.) Fr. Cke., Hand. Austr. Fungi, No. 16 (Q'land, N.S. Wales, Vict., Tasm.). Victoria: Ararat (E. J. Semmens), spores 17 to 19×10·4 μ. South Australia: Spores 16 to 22·5×9·5 μ; amongst grass usually under trees, National Park, South Australia, April, May, eaten by the author; near Mount Lofty, March, June; Kinchina, July.

388. *Lepiota Morgani*, Pk. We refer the following, chiefly on account of the definite but slight greenish tint of the spores, to this American species, but with considerable doubt. Our specimens are smaller than the usual dimensions given for *L. Morgani*, the plant is about as broad as long, the gills though free are not remote from the stem, the latter is hollow, and the ample ring appears to be fixed. Pileus 3 inches or more across, convex, broadly gibbous, cuticle cracked, with a dark-brown crust at the apex, the rest whitish with pale-brown, rather imbricate, fibrous scales. Gills just free, close, white, then with a pale-green tint. Stem 3 inches or more long, moderately slender, striate, pale brownish, hollow. Ring ample, moderately superior, apparently fixed. Smell strong. Spores microscopically pale dingy-greenish, oblique, not thick-walled, 8·5 to 10·4 by 6 to 7 μ. On the ground, Moore Park, Sydney, Dec. 2, 1917.

389. *Lepiota naucina*, Fr. Cke., Hand Austr. Fungi, No. 31 (Vict.). Clel and Cheel, Agric. Gaz. of N.S Wales, xxvi., April, 1915, p 33 (N.S. Wales). South Australia: In grass, Beaumont, Feb., June (eaten by slugs), centre of the pileus in some specimens Buffy Brown or Wood Brown (xl.)

390. *Lepiota licmophora*, B. and Br. Clel. and Cheel, Agric. Gaz. of N.S. Wales, xxvi., April, 1915, p. 332. N S Wales: Mosman, Jan., March.

391. *Lepiota cepaestipes*, (Sow.) Fr. Cke., Hand. Austr. Fungi (Q'land). Clel. and Cheel, Agric. Gaz. N.S. Wales, xxvi., April, 1915, p. 331. We have already recorded from Australia, as this species, a small-spored plant (like that described by Petch, Anns. Roy. Bot. Gdns., Peradeniya), and referred to a large-spored plant (like that met with in America—Peck, N. York State Mus., Bull. 94, 1904, p. 44), as being "obviously a different species," though the description of *L. cepaestipes* would apply to it. We have collected this large-spored form in the Botanic Gardens, Sydney, in April. Pileus Primrose Yellow, Lemon Yellow (Dauthenay, pl. 19, ton 1), stem the same colour from ton 1 above to ton 2 below, spores 8 to 12×6·8 to 7·2 μ, Neutral Bay, March.

392. *Lepiota cristata*, Fr. Clel. and Cheel, Agric. Gaz. N.S. Wales, xxvii., Feb., 1916, p. 99. South Australian specimens do not seem to attain a diameter of more than an inch. Pileus Chestnut Brown (xiv.); base of stem Light Russet Vinaceous (xxxix.). Spores usually 4·8 to 6·4×3 to 3·5 μ. Amongst grass, Adelaide and suburbs, June (Miss Fiveash, Watercolour No. 10); under pines, Frome Road, Adelaide, May, spores 8 to 8·5×5 μ.

Armillaria.

393 (iii., 92). *Armillaria mellea*, (Vahl.). Fr. N.S. Wales: Bradley Head, April; Taronga Park, May; Mosman, May, pileus almost black, definite remains of a pale-brownish ring ¾ inch below the pileus, and just below the pileus a flimsy veil rupturing to form a very definite second ring; National Park, May, pileus Raw Sienna to Sudan Brown (iii.), ring further away than usual from the gills (1 inch), spores 7·5 to 8·5×5 μ; Neutral Bay, July. South Australia: Kuitpo, at base of stump, May; near the base of *Acacia pycnantha*, Benth., National Park,

Aug., also in April; Mount Lofty, June, pileus Buckthorn Brown to Dresden Brown (xv.), punctate with darker squames

MYCENA.

394. *Mycena galericulata*, (Scop.) Fr. A common species on posts, stumps, and at the bases of trees, rather variable, densely caespitose, apparently more slender and with less tendency to expand than is the case with the British plant. The gills often have a greyish tint and the decurrent tooth is not marked. Possibly the Australian plant is specifically distinct. Pileus Blackish Brown to Dusky Drab (xlv.) to Wood Brown (xl.); the lower part of the stem Army Brown to Natal Brown (xl.). South Australia: National Park, on posts, etc., July; Mount Lofty, June, July; Belair, June.

395 (iii., 132). *Mycena viscido-cruenta*, nom nov In a previous number of this series (iii., 132) we have described a new species of *Mycena* as *M. coccinea* (*coccineus* in error). As this name is preoccupied (*M coccinea*, (Sow.) Quel.), it is necessary to change it, and so the specific name *viscido-cruenta* has been chosen, as indicating its viscid nature when moist and the blood-red colour. N.S. Wales: Mosman, April; Lisarow, Dec. South Australia: Waterfall Gully, June; National Park, May.

396. *Mycena tenerrima*, Berk. South Australia. At first a minute knob with frosted granules. Pileus ⅛ inch + (3 mm. +), broadly campanulate or conico-convex, the centre slightly flat on top or depressed, striate, frosted with granules, pure white or with a greyish tinge. Gills adnexed or just free, no collar, slightly ventricose. Stem ½ inch (10 mm.) high, very slender, with white granules or minute hairs, attached to wood by a minute mealy bulb. Microscopically the cell-like hyphae of the pileus are covered with granules. Spores not seen On the base of a Eucalyptus trunk, Green Hill Road, June, 1923

OMPHALIA.

397. *Omphalia chromacea*, n. sp.—Whole plant near Deep Chrome (iii.) or a little yellower when moist, or Yellow Ochre (xv.), drying to an opaque Pale Orange Yellow (iii.) to Light Orange Yellow (iii.), the gills and stem remaining nearer Deep Chrome. Pileus up to ¾ inch in diameter, rarely reaching 1 inch, convex, then sometimes plane, slightly umbilicate, irregularly rugose. Gills decurrent, edges rather thick, a few short ones interposed, distant, sometimes forked or anastomosing or with buttressing folds. Stem up to ¾ inch long, slender, equal or slightly attenuated upwards, tough, surface dull, solid, flesh yellow. Spores narrow pear-shaped, oblique, 6 to 9·5 by 3 to 5 μ. Cystidia not seen. Gregarious on bare sandy loam or amongst low moss. South Australia: Mount Lofty, April, June, July (whole plant Yellow Ochre, pileus a little more orange, spores 8 to 8·5×5 μ), Aug., Sept.; Waterfall Gully, June (spores 8 to 9·5 by 3·8 μ); National Park, June; Adelaide, July. N.S. Wales: Ryde, May (edge of the pileus turned in when young); Tuggerah, Oct., on damp bank (spores 5 to 7 by 3·4 μ); Leura, June; Bumberry, Sept.; near Dubbo, Aug.; The Rock, July; a white form was found at Neutral Bay, Sydney, in May (spores 7 by 3·5 μ).

Planta chromacea, hygrophana. Pileus ad 16, rariter 25 mm. latus, convexus, interdum planus subumbilicatus, irregularitur rugosus. Lamellae decurrentes, marginibus subcrassis, distantes, interdum furcatae vel anastomosae vel plicis suffultis. Stipes ad 10 mm. latus, tenuis, equalis vel sursum attenuatus, solidus. Sporae pyriformes, obliquae, 6-9·5×3·5 μ.

The following resemble *Omphalia chromacea*, but the spores are narrower:—Pileus pallid brownish-yellow to brownish-orange. Gills whitish. Stem pale

brownish-yellow, hollow above where it expands into the gills. Spores 4·5 to 7×2 to 2·5 μ. N.S. Wales: On the ground, amongst moss, Neutral Bay, Sydney, May (D. I. Cleland, Watercolour No. 16). Also Neutral Bay, May and June, spores elongated, narrow, 5·2×2 μ, occasionally 7×2 μ; Lisarow, June, spores 5×2 μ; N.S. Wales: spores 5·2×2·2 μ.

COLLYBIA.

398 (iii., 119). *Collybia radicata*, (Relh.) Berk. Spores 16 to 21×11 μ. N.S. Wales: Chatswood, Sydney, March, May (Miss Clarke, Watercolour No. 149); Tuggerah, Oct.; Lisarow, June; Bulli Pass, April; Bumberry, Sept. Vict.: Ararat, E. J. Semmens, No. 3. South Australia: National Park, Aug.; Mount Lofty, June, gills subdecurrent, not adnexed; Beaumont, near Adelaide, June, July.

399 (iii., 120). *Collybia velutipes*, (Curt.) Fr. Spores 7 to 8·5 by 3 to 5 μ (Australian), 7 to 9·5 by 4·5 to 4·8 (New Zealand). N.S. Wales: Dorrigo, Jan. Vict.: Aug., Mr. Brittlebark, Nos. 11, 12. New Zealand: Dunedin, Queenstown, and Invercargill, June; Wairaroa, on dead logs in forest, Jan., G. H. Cunningham, No. 675.

MARASMIUS.

400. *Marasmius foetidus*, (Sow.) Fr. Cke., Hand. Austr. Fungi, No. 427 (Q'land). Pileus up to ⅞ inch in diameter, irregular, convex, then nearly plane, plicate, near Burnt Umber (xxvii.) when moist, drying to near Walnut Brown (xxvii.) Gills thick, adnate to slightly decurrent, pruinose, near Light Cinnamon Drab (xlvi.). Stem ½ inch high, sometimes attenuated downwards, sometimes flattened, velvety, blackish. A few spores (?) seen, 9×5·5 μ. Smell distinctly foetid. South Australia: On the bark, several feet up the trunk, of living *Eucalyptus obliqua*, L'H., Mount Lofty Summit, April, 1924.

401 (iii., 130). *Marasmius equi-crinis*, F. v. M. South Australia: The pileus is a pallid biscuit-colour (near Tawny Olive, xxix.), the centre markedly dimpled with a characteristic minute dark knob in the centre of the dimple giving an appearance of great depth to the dimple; gills 8 to 11, attached to a collar; the stem brown, pallid below the pileus, up to several inches long; spores elongated, elliptical, 7·5 to 9×4·5 μ to 5·5 μ; the mycelium tough like horsehair, brown, tangled amongst fallen leaves, etc., hidden in grass; Mount Lofty, March and April; National Park, April; Green Hill Road, July (Form. Sp., No. 322). The South Australian plants seem exactly like those previously recorded for New South Wales.

HYGROPHORUS.

402 (iii., 124). *Hygrophorus miniatus*, Fr. We have already discussed the reason for referring the Australian plants to this species. Our plants resemble somewhat the description given in Cooke (No. 385) of *H. scarlatinus*, Kalchb., but the spores of this species are said to be subglobose, 3 to 4 μ. Vict.: Ararat, June and July, E. J. Semmens (Nos. 107, 128). South Australia: Pileus Scarlet to Scarlet Red to Carmine (i.), upper part of the stem of the same colour, becoming yellowish below, gills adnate with a tendency to decurrence, whitish becoming yellowish, spores elliptical 6·5 to 8×3·2 μ, Green Hill Road, amongst moss, June, July.

403 (iii., 125). *Hygrophorus conicus*, Fr. N.S. Wales: Mosman, April; National Park, May. South Australia: Botanic Gardens, in grass, June, pileus Ox-blood Red (i.), up to 2¼ ins. in diameter, the stem the colour of the pileus but slightly greenish below.

404. *Hygrophorus candidus*, Cke. and Mass. Cke., Hand. Austr. Fungi, No. 379 (Vict.). South Australia: Pileus and stem glutinous, fragile. Pileus

up to 2 inches in diameter, conico-convex to convex, then expanding and nearly plane, gibbous to umbonate, edge turned in and thin and sometimes striate, pure white with brownish-biscuity tints round the centre. Gills adnate or adnexed, close, slightly ventricose, narrow triangular on section, creamy-white. Stem up to 2½ inches high, rather flexuous, moderately slender (up to ¼ inch thick above), attenuated downwards, slightly hollow, white. Spores elliptical to subspherical, sometimes a little irregular but not rough, 6·5×4 μ, 5·2×4·8, 4·5×3 μ. Under Eucalypts, Kinchina, July; Mount Lofty, July; amongst grass under trees, Beaumont Common, May (the thick gluten forming a pseudo-veil in the young plant); National Park, April.

CANTHARELLUS.

405 (iii., 101). *Cantharellus lilacinus*, Clel. and Cheel South Australia: Mount Lofty, July.

PINK-SPORED AGARICACEAE

VOLVARIA.

406. *Volvaria speciosa*, Fr. Spores pale brownish, 14 to 15·5 by 8·5 μ. N.S. Wales: Mosman, May, pileus whitish with a slight brownish tint, gills with a flesh tint.

407. *Volvaria bombycina*, (Schaeff.) Fr. We attribute the following to this species:—Pileus 4 inches in diameter, broadly conical with a large obtuse umbo, smoky-brown, cuticle cracking in a radiate fashion leaving a pallid white between the irregular patches and fibrillae of the cuticle. Gills close, quite free, whitish with a pink tinge, becoming salmon coloured Stem 4½ inches high, stout, attenuated upwards, ⅜ inch thick above, the base much swollen (1·⅞ inch), solid, surrounded by a marked volva with a wide, free, slightly lobed edge Mushroom smell. Spores oval, 8·2 by 5 μ, no cystidia seen. On soil on an old newspaper, Botanic Gardens, Sydney, Jan, 1917 (Miss Clarke, Watercolour No. 143)

408. *Volvaria parvula*, (Weinm.) Fr. N.S. Wales: Pileus ⅜ inch in diameter, convex, gibbous (?), slightly viscid (?), white. Gills apparently adnate (? free), whitish, then pale brownish. Stem ¾ inch high, slender, whitish. Volva marked, upper edge widely free. Spores pale tinted, 7 by 4·2 μ On the ground, National Park, N.S. Wales, May, 1919.

409. *Volvaria gloiocephala*, (DC.) Fr. (Rec. for South Australia in error as *Volvaria speciosa (?)* in Jour. Proc. Roy. Soc. N.S Wales, xlvii., 1914, p 434). South Australia: Pileus at first rather globose, then conico-convex and umbonate, finally nearly plane with a broad obtuse umbo, up to 3¼ inches in diameter, viscid, when dry shining and finely matt at the apex, becoming finely fibrillose outwards, occasionally with white patches of the volva remaining, Light Greyish Olive (xlvi.) to Greyish Olive to Pale Smoky Grey, sometimes Clove Brown (xl.). Gills close, just reaching the stem, 7 mm. deep, whitish, then light brownish-vinaceous. Stem up to 6 inches high, very slightly fibrously striate, 1 cm. in diameter in the middle, rather expanded above, base bulbous, solid, whitish, becoming faintly tinged greyish or brownish. Flesh of the pileus watery whitish-grey, of the stem white with whitish-grey at the periphery. Volva ample, free, white, spores elliptical, 13 to 18×8 to 10·5 μ. Amongst dead herbage (thistles, "Salvation Jane"), etc. Suburbs of Adelaide, June, July; Waterfall Gully, June.

CLAUDOPUS.

410. *Claudopus variabilis*, (Pers.) W. G. Sm., var. *sphaerosporus*, Pat. Pileus up to ½ inch in diameter, convex to nearly plane, sometimes irregular, more or less flabelliform, matt or somewhat villous to floccose, edge slightly incurved, whitish, sometimes with tinges of yellow-brown; gills moderately close,

many short, adnate or slightly decurrent, radiating from a slightly fluffy lateral attachment, whitish with a faint salmon tint or pale cream, becoming pale brownish (near Sayal Brown, xxix.); sometimes with a nearly lateral, very short and hardly existent, whitish stem. Spores microscopically pale tinted to pallid brownish, elliptical, oblique, 6·8 to 8×4·2 to 5·2 μ. On logs, fallen sticks, inside a burnt hollow stump, etc. N.S. Wales: North Bridge, Sydney, July; Mosman, Oct.; Dorrigo, Jan. Vict.: Craigie, June (E. J. Semmens, No. 83). South Australia: Mount Lofty, June, in one case attached round a stem (Form. Sp., No. 287).

BROWN-SPORED AGARICACEAE.

Locellinia.

411. *Locellinia australiensis,* Clel. and Cheel. South Australia: Kuitpo, May, under *Eucalyptus* sp., gills becoming Ochraceous Tawny (xv.); Mount Lofty, July.

Crepidotus.

412. *Crepidotus eucalyptorum,* n sp. Pileus ½ to 2¼ inches laterally, ¼ to 1½ inches from before backwards, convex, sometimes a little gibbous, surface matt to fibro-villous, sometimes becoming fibrillosely scaly, edge a little turned in, watery-brown to yellowish-brown—near Old Gold (xvi), the villous projections Buff Yellow (iv.) to browner; a little paler than Saccardo's Umber (xxix.)—drying paler and sometimes to a dark biscuit-brown. Gills moderately close to rather distant, pallid brownish, pallid dingy yellowish, pale yellowish-brown or earthy-brown—paler than Saccardo's Umber (xxix), a little browner than Avellaneous (xl.). Flabelliform, laterally attached by a constricted base, no definite stem. Flesh thick at centre, pellucid soapy looking. Spore mass near Raw Umber (iii.), spores microscopically dull pale brown, oblique, 7·2 to 10 by 5·2 to 6 μ. On trunks of living Eucalypts. South Australia: On living trunks of *E. viminalis,* Lab., *E. odorata,* F. v. M., etc., up to a height of 15 feet, National Park, June, 1917 (Watercolour, Miss A. Rennie, No. 5); on trunks of *E. leucoxylon,* F. v. M., Mount Lofty, July; Mount Lofty, June. Vict.: Ararat, July, 1918 (E. J. Semmens, No. 121); on trunk of *E. hemiphloia,* F. v. M., Craigie, June, 1917 (E. J. Semmens, No. 57). N.S. Wales: Pileus fibro-villous, yellow-brown, attached behind by a broad base, spores yellow-brown, on trunks of *Eucalyptus* sp., The Rock, July; laterally attached by a constricted base, often with white fluffy mycelium, on trunks of *E. rostrata,* Schl. (or *E. tereticornis),* Narrabri, May; pileus now smooth, on *E. Baueriana,* var. *conica,* Maid., Pilliga Scrub, Oct.

Pileus 1·2 ad 5·6 cm. latus × ·6 ad 3·8 cm., convexus, interdum subgibbosus, fibro-villosus, interdum fibrilloso-squamosus, margine subinvolute, flavo-fulvus. Lamellae subdensae ad subdistantes, pallido-fuscae. Planta flabelliformis, lateraliter adjuncta base constricto, astipitata. Caro crassa, subpellucida. Sporae fuscae, obliquae, 7·2-10×5·2-6 μ. De Eucalypti trunco crescens.

413 (i., 54). *Crepidotus globigerus,* Berk. N.S. Wales: The Comboyne, Sept., Bulli Pass, Nov. (Miss Clarke, Watercolour N: 164).

414. *Crepidotus subhaustellaris,* n. sp. Pileus ½ up to occasionally 1 inch broad, up to ¾ inch from before backwards, convex or irregularly convex, then often wavy and upturned, surface dull and matt becoming shiny, the edge turned in when young, pale brown to tanny or reddish-brown, drying to a biscuit colour (pileus drying to Pale Alutaceous Buff, xv., near Liver Brown, xiv., towards the attachment). Gills adnate, close, many short, dingy brown to dark earthy brown (Cinnamon Brown, xv.). Stem excentric or nearly lateral, curved, short or very short, swollen below the gills, with a mealy-white bloom and brownish beneath

this and a fluffy base. Spore mass near Mummy Brown, xv., spores microscopically pale dingy brown to dull vinous-brown, elliptical, oblique, one side a little flattened and one end more pointed, 6·5 to 7·5×4·2 to 5 μ. On trunks of living Eucalypts *(E. capitellata,* Sm., etc.), on old bagging and on a dead *Xanthorrhoea* scape. South Australia: Mount Lofty, April, May, June, July, Sept.; National Park, June (Miss A. Rennie, Watercolour No. 4); Kuitpo, Oct. Vict.: Ararat, July (E. J. Semmens, No. 132).

Pileus ad 1·2, rariter 2·5 cm. latus × 1·8 cm., convexus vel irregulariter convexus, deinde saepe undosus et recurvatus, 'matt' deinde splendens, margine primum involuto altuaceo-fuscus. Lamellae adnatae, compactae, cinnamoneo-fuscae. Stipes eccentricus vel sublateralis, curvus, brevis vel perbrevis, sublamillis inflatus, subfarinaceus, subfuscus, base villoso. Sporae fuscae, ellipticae, obliquae, 6·5-7·5×4·2-5 μ.

BLACK-SPORED AGARICACEAE

PANAEOLUS

415. *Panaeolus retirugis,* Fr. South Australia: On dung, spores 15·2 to 17·8×9 to 10·7 μ. Pileus pallid greyish-brown; stem near Vinaceous Buff (xl.). Glen Osmond and Beaumont, June to Sept.; Mount Compass, Oct

COPRINUS.

416. *Coprinus comatus,* Fr. Clel. and Cheel, Proc. Linn Soc N.S. Wales, xli., 1916, p. 853. N.S. Wales: Moore Park, Sydney, April, Dec Vict.: Melbourne, May, spores 10·4 to 12×7 μ. South Australia: On lawn, Botanic Gardens, June (spores microscopically dark brown, 9·5 to 11×6·5, occasionally 14·5×8 μ); Beaumont, June (spores nearly black, 16 to 17·5×9·5 μ).

417 (iv., 271). *Coprinus micaceus,* Fr N.S. Wales: Mosman, May; Milson Island, Hawkesbury River, Nov., Dec.

418. *Coprinus sterquilinus,* Fr. South Australia: When young broadly conical; pileus 1 inch high, the stem 2 inches elongating to 4 inches; pileus pure white with shaggy, scurfy scales, striate, the pink of the gills showing through; gills free, close, edges pinky-brown. Stem white, attenuated upwards, the base bulbous, hollow; a rather imperfect ring just above the base; spores black, 19·6 to 21×12·5 μ; on dung, Waterfall Gully, Sept.

419. *Coprinus niveus,* (Pers.) Fr. Cke., Hand Austr. Fungi, No. 348, *vis.* (Vict.) South Australia: Pileus and stem nearly white, conical; edge of the pileus curly; gills adnate; stem hollow; no strong smell; spores subspherical to elliptical, black, 11 to 12·8 μ, 11×8 to 9·5 μ, in one collection 13·8 to 15·5×10 to 12μ ; on dung, Burnside, Beaumont, and National Park, April, July; Encounter Bay, Aug. This pure-white, dung-inhabiting species is evidently not *C. narcoticus,* (Bätsch.) Fr., lacking the smell. The spores are larger than those of *C. stercorarius,* Fr. (7 to 10×7 to 8 μ. Rea (Brit. Basidiomyc., p. 505) says the gills are adnexed in *C. niveus* (we noted them as adnate in our specimens) and the spores are 15×10 to 12 μ, which are larger than those of our plants except in one collection, that from the National Park.

420. *Coprinus ephemerus,* (Bull.) Fr. Clel. and Cheel, Proc. Linn. Soc. N.S. Wales, xli., 1916, p. 856. We refer the following to this species, though the disc is not elevated and the spores attain to a larger size than the measurements (8 to 10×5·5 to 8 μ) given by Rea. It may be *C. curtus,* Kalchb. (= *C. plicatiloides,* Buller). South Australia: At first a minute yellowish-brown button; then conico-cylindrical, striate and yellowish-brown; then becoming more conical; finally conico-expanded and eventually upturned; the apex brownish, not specially raised or depressed, the rest of the pileus greyish and finely double ribbed; gills close, narrow, just reaching the stem, blackish; stem

up to 2¼ inches high, slightly attenuated upwards, hollow, white, silky with a slight mealiness; spores elliptical, black, 8·5 to 14·5×6·4 to 8μ; on dung, Adelaide, Sept.

421. *Coprinus plicatilis,* (Curt.) Fr. Clel, and Cheel, Proc. Linn. Soc. N.S. Wales, xli., 1916, p. 858 In our plants referred to this species, the spores are larger than the measurements (10 to 12×8 to 9 μ) given by Rea, and the stem is white, not pallid. South Australia: Pileus conico-cylindrical, 7-16ths inch high and 5-16ths inch broad, then conico-campanulate, then convex and up to 1 inch broad, the centre finally dimpled, darkish brown in the centre, succeeded by a pallid biscuit-coloured disc, the rest of the pileus plicate and greyish biscuit-coloured, a few glistening particles present, membranaceous; gills close, narrow, ascending, just reaching the stem and attached to a collar, greyish, edges white; stem 1½ to 3½ inches high, slender, slightly attenuated upwards, hollow, white; spores dark brown to black, 12·5 to 16×7 to 10 μ. On the bare ground or amongst grass or garden plants, Beaumont, May, June; Waterfall Gully, Sept. (Herb., J. B. C., Form. Sp., No. 328). A sterile form was found at Beaumont in May at the same time as fertile specimens and at first suggested a *Galera.* The pileus and gills were yellowish-brown from the absence of spores (Form. Sp, No. 329)

MONTAGNITES.

422. *Montagnites Candollei,* Fr. In identifying a specimen for us, C. G Lloyd states that he considers that "there is but one species (of this genus), widespread in sandy countries, varying as to stature and spore size, but all one All have a volva if perfect." This being Lloyd's opinion, we place all our plants under this specific determination, though they vary considerably. We append short descriptions of the forms met with:—

(a) Stem slender, up to 2 inches high, sometimes attenuated upwards, fibrous-scaly, striate, firm. Volva definite, nearly clasping the base of the stem, the free edge jagged. Expanded disc-like upper portion of the stem up to 1½ inches in diameter, plane or convex and dimpled Gills up to ⅜ inch long, curved downwards. Spores black or dark purplish, elliptical, one end more pointed, 15 to 24×9·5 to 12 μ, rarely 27×21 μ. South Australia, Miller Creek, near Mount Eba, Central South Australia, Aug. (Dr. T. Campbell; identified by Lloyd, No. 791); Ooldea, Aug., a number of specimens in sandy soil. Western Australia: Kurrawang (Mrs. A. F. Cleland).

(b) Similar to the above, but longer (3 inches) and generally larger; spores blackish to dark brown, elliptical to irregular or almost triangular, 7·5×5·5 μ. On a sandhill, Waitpinga, Encounter Bay, Jan.

(c) A coarse plant. Stem 3½ inches high, attenuated upwards, ½ inch thick in the middle, in the middle part with several broad, thick, veil-like dependent bands with texture firm and corky and brownish-straw in colour. No volva now detectable. Disc-like expansion of the stem ¾ inch in diameter, convex. Spores dark purple, spherical, smooth, 5·4 to 6·4 μ. Miller Creek, near Mount Eba, Aug. (Dr. T. Campbell). We have only the one, slightly injured, specimen of this form. It seems undoubtedly to be a *Montagnites,* but it seems to us to be probably specifically different from our other specimens. Till more material is available we, however, leave it under *M. Candollei.*

Several years ago, at Forbes, in New South Wales, we collected a fungus (which has been mislaid) which we now believe to have been *M. Candollei.* It had black spores and at the time suggested to us a rapidly dried *Coprinus.*

POLYPORACEAE.

FISTULINA.

423. *Fistulina hepatica*, Fr. Cke., Hand. Austr. Fungi, No. 582 (W. Austr.). Vict.: Cuticle rough and brown with a red tinge, flesh translucent with white striae running through it, pores of a delicate flesh-pink, a few oval pale yellowish-brown spores seen 7 to 8×5·2 μ, at foot of an old decayed stump, Ararat, May (E. J. Semmens, No. 83). South Australia: Rather flabelliform in shape, 3 inches deep and wide, dark brown (near Rood's Brown, xxviii.), villous; pores near Japan Rose (xxviii.), the tubes separate, coral pinky-brown, then brownish-pink; flesh shows brown and paler layers; spores whitish, 4·8×3·2 μ; on dead stumps and at the base of Eucalypts, Mount Lofty, June, 1921.

STROBILOMYCES.

424 (iii., 158). *Strobilomyces pallescens*, Cke. and Mass. N.S. Wales: When quite young, pileus globose, ¾ inch in diameter, constricted round the stem, the periphery expanding a little and projecting from the stem, the stem 3 inches high, attenuated upwards. When adult, the pileus up to 2½ inches in diameter, slightly convex, shaggy, or broken up into large scale-like warts, some ½ inch in diameter and very thick with fissures between them, the tops of the warts dirty brown, the bases almost crimson-lake in colour, the warts somewhat polygonal in shape and in arrangement resembling a pine-apple, the pale straw-coloured flesh exposed in the cracks, when young the pileus floccose from felted fibrils aggregating to form early scales, colours noted when young Pale Flesh (Dauthenay, pl. 136, ton 4) to browner and darker than Pale Blush (pl. 137, ton 4), when older with pinkish-purple marks. Hymenial surface convex, the middle tubes up to ½ inch long, shortening inwards and outwards, just adnexed and almost free, pores fairly large, angular, bright yellow to yellowish-brown becoming dark. Veil marked when young, turned downwards on to the stem and forming a narrow sleeve adpressed to this, rupturing to leave long, jagged, dirty-straw-coloured streamers round the edges of the pileus, rather scaly, in parts tinted pinkish-purple. Stem up to 3 to 6 inches high, markedly bulbous, attenuated to ½ inch in diameter in the middle, dirty white in colour, often pinkish-purple to a dull crimson-lake tint above and the lower part sometimes greyish, solid, when not quite mature with numerous ring-like remains of the veil on the stem. Flesh of the pileus turning blue on section, that of the stem reddish. Spores yellow-brown, 19 to 20·5×7·2 to 9 μ. At or near the base of *Angophora lanceolata*, Cav., Neutral Bay, March, and Bradley Head, April.

425 (iii., 159). *Strobilomyces floccopus*, Rost. N.S. Wales: Kendall, May, spores pear-shaped, dark brown, reticulated, 8·5 to 10·4×7 to 8·5 μ.

BOLETUS.

426. *Boletus luteus* (L.). In all cases, under or near species of *Pinus*. Spores mummy-shaped, brown, 7·6 to 11×3·2 to 5 μ. N.S. Wales: Mittagong, June (ring marked). South Australia: Beaumont, Adelaide, May; Walkerville, Adelaide, Sept.; Green Hill Road, July (after heavy rain, at first intensely glutinous and almost white with an ample white veil, becoming dirty brown on the veil and pileus, the cut base of the stem turning brownish); Mount Lofty, April, June (young specimens were eaten and proved palatable); Upper Sturt and National Park (also forms without a ring), May; Kuitpo, May (also forms without a ring).

427. *Boletus megalosporus*, Berk. Clel. and Cheel, Proc. Roy. Soc. N.S. Wales, xlviii., 1914, p. 44. N.S. Wales: Pileus up to 2½ to 4½ inches in diameter,

covered with a fawny meal or villous becoming smooth, then sticky or viscid even when nearly dry so as to adhere to paper, convex, easily indented, pale tan to reddish-brown (tints noted—Maize Yellow, Dauthenay, pl. 36, ton 4; Fawn, pl. 308, ton 1). Pores small to rather large, whitish, then flesh coloured, pallid brown or pale fleshy-brown (paler than Madder Brown, Dauthenay), the tubes up to ½ inch long, with a sulcus round the stem. Stem 2½ to 4 inches high, rather slender (½ inch to ⅝ inch or more below), attenuated upwards, whitish or with tints of brown (Creamy White, Dauthenay), deeply and irregularly elongated, lacunose throughout, rooting with mycelial threads at the base, with spongy pith or markedly hollow. Spores mummy-shaped, smooth, brownish, 13·8 to 19×5 to 6·5 μ. Taste bitter. N.S. Wales: National Park, May (Miss Clarke, Watercolour); Chatswood, May; under *Casuarina*, North Bridge, Sydney, April (edge of the pileus inturned with attached remains of a veil) This species in general appearance resembles *B. lacunosus*, Cke. and Mass., but the spores differ markedly. We have had difficulty also in separating some examples of our *B. austro-felleus* when the reticulations become above almost areolate or lacunose.

428. *Boletus lacunosus*, Cke. and Mass. Clel. and Cheel, Proc. Roy. Soc. N.S. Wales, xlvii., 1914, p. 441. N.S. Wales: Pileus soft, pores adnate, base of the stem or the whole stem lacunose, spores warty, swollen in the middle with pointed ends, yellowish-brown, 12 to 13×6·5 to 6·8 μ. Colour tints noted:— Plieus tints of Buff Pink to Onion-skin Pink (Ridgway, xxvii.), Pale Ecru (Dauthenay, pl. 66, ton 4); pores near Light Russet Vinaceous (Ridgway, xxxix.), Lilacy White (Dauthenay, pl. 7, ton 4); stem Maize Yellow (Dauthenay, pl. 36, ton 2); National Park, May.

429. *Boletus (Tyropilus) austrofelleus*, n. sp. Pileus 2 to 5 inches in diameter, irregularly convex to nearly plane, slightly viscid when moist, villous or matt when dry, sometimes feeling like soft leather, Mineral Brown (Dauthenay, pl. 339, tons 1 and 2), dull pale brown, cinnamon-brown, dark reddish-umber, rich reddish-brown to dark tan, pale brown with a pinkish tinge or dark rusty-brown to a little yellower than Burnt Umber (pl. 304, ton 1). Pores rather pallid with a flesh tint, pinkish-tan, pinkish-brown or fleshy-brown, turning reddish-brown or brownish, small, adnate or with a slight sulcus round the stem, the tubes ¼ to ¾ inch long, attenuated both ways, pallid fleshy-brown (a little darker than Rosy White—Dauthenay, pl. 8, ton 4), or pale wood colour, sometimes showing a greenish tinge. Stem 2 to 3½ inches high, up to 1 inch thick, sometimes slightly attenuated downwards or slightly thickened below, the root somewhat pointed, above pale brownish with darker reticulated lines and below darker brown and sometimes punctate with brown dots or the colour dark pinkish-brown or reddish-brown; sometimes the stem is streaked and not reticulated. Flesh up to ¾ inch thick, whitish, usually turning slightly reddish-brown. Taste usually mild, in one case noted as slightly bitter and only in one as very bitter Rather strong radishy smell. Spores elongated mummy-shape, almost white to pale brown, 10·4 (rarely 8·5) to 14 (rarely 15·5)×3·4 to 5·5 μ. Brown cystidia seen in one collection (at the base of an old stump), ventricose, 34 to 38×12 μ. N.S. Wales: Sydney (Neutral Bay, Mosman, etc.), March, April, May, Dec.; Milson Island, Hawkesbury River, April (Miss Clarke, Watercolours Nos. 62 and 200; D. I. Cleland, Watercolour No. 7). The following differ slightly:—Pileus, soft almost like cotton-wool and easily indented, viscid with an easily separable cuticle leaving a white flesh, the colour of a yeast bun but paler yellowish-brown at the periphery; pores rather hexagonal, moderately large, about 7 in ·5 cm., of a dingy fleshy-brown; the stem below striate by slightly raised vaguely anastomosing brownish lines, taste mild, spores pale tinted, 11 to

$12 \times 4 \cdot 2\ \mu$; Neutral Bay, April--these specimens resemble *B. megalosporus*, Berk., except that the stem is not lacunose but only vaguely reticulated and the spores are smaller. Other specimens collected also at Neutral Bay in April are noted as having a slightly curved pileus, not viscid but feeling like a kid glove; adnate pinkish-flesh tubes; the stem streaked but not reticulated; the spores pallid, $10 \cdot 4$ to $13 \cdot 8 \times 4\ \mu$; and the taste very bitter. Large specimens collected at Bradley Head in April, had stems which were reticulated and almost areolate or lacunose above, in colour near Burnt Umber (Dauthenay, pl 304, ton 2), spores pallid, $13 \cdot 8$ to $15 \cdot 5 \times 5\ \mu$. This species would seem almost to grade into *B. megalosporus*, Berk. In fact, we placed the last-mentioned specimens at first under the latter species.

Pileus 5 ad 12·5 cm. latus, irregulariter convexus ad subplanus, subviscidus, exsiccatus subtomentosus, fuscus, cinnamoneo-fuscus, rubido-fuscus, vel pallido-fuscus. Porae subparvae, carneo-pallidae, deinde rubidae adnatae vel peri stipem parvo sulco, tubulae 6-18 mm. longae, bifariam attenuatae, pallido-carneo-rubidae. Stipes 5 ad 9 cm. longus, ad 2·5 cm. crassus, sursum pallido-fuscus et lineis reticulatis, deorsum fuscus et punctatus vel rubido-fuscus. Caro ad 18 mm. crassus, albidus, saepe mutans subrubidus. Sapor fere mitis, rariter acerbus. Sporae elongato-fusiformes, albidae vel pallido-rubido-albidae, fere $10 \cdot 4$-14, rariter $8 \cdot 5$-$15 \cdot 5 \times 3 \cdot 4$-$5 \cdot 5\ \mu$.

430. *Boletus (Gyroporus) caespitosus*, n. sp. Caespitose. Pileus up to 4 inches or more in diameter, convex and wavy, sometimes with the surface cracking, surface matt, dull and soft but sometimes rather shiny, Cinnamon Buff to Clay Colour (xxix.) or near Isabella Colour (xxx.). Pores rather small, beginning as minute, irregular reticulations, rather irregular, dissepiments thick, with a sulcus round the stem, pallid brownish-white or the colour of the cap (near Ivory Yellow, xxx.), becoming pale wood colour when bruised, old or cut, tubes up to $\frac{1}{4}$ inch to $\frac{1}{2}$ inch long, attenuated both ways. Stem up to $3\frac{1}{2}$ inches high, swollen in the middle (up to $1 \cdot \frac{5}{8}$ to 2 inches), up to $\frac{3}{4}$ to 1 inch thick above and to $1 \cdot \frac{1}{8}$ to $1\frac{1}{2}$ inches below, surface matt, the colour of the pileus, punctate with fine brownish granules. Flesh thick (up to 1 inch), white turning brownish or yellowish-brown. Spores oval to subspherical, white or slightly tinted, 8 to $8 \cdot 9 \times 5$ to $5 \cdot 5\ \mu$. Moderately strong smell, taste mild. South Australia: At the base of a dead *Eucalyptus rostrata*, Schl., stump on successive years, Burnside, Adelaide, May; National Park, May. N.S. Wales: Terrigal, June (stem bulbous, spores with a central gutta).

Plantae caespitosae. Pileus ad 10 cm. latus vel plus, convexus et undulatus, mollis et non-nitidus, interdum subnitidus, cinnamoneo-luteus vel isabellinus. Porae subparvae, subirregulares, dissepimentis crassis, peri stipem sulco, eburneo-luteae, tubulae ad ·6-1·2 cm. longae. Stipes ad 8·7 cm. altus, in media parte inflatus, coloribus simillibus pileo, punctatus granulis. Caro crassus, albidus, mutans sub-brunneus. Sporae ovales ad subsphericales, albidae, 8-$8 \cdot 9 \times 5$-$5 \cdot 5\ \mu$.

431. *Boletus ovalisporus*, n. sp. Pileus $2\frac{1}{4}$ inches broad, irregularly convex to upturned, surface matt, tinted with shades of yellow and red, more yellow in the centre and more reddish round the periphery. Pores rather small, with a sulcus round the stem, tubes $\frac{1}{4}$ inch deep, mustard-yellow. Stem 1 inch high, $\frac{1}{2}$ inch thick, slightly attenuated downwards, surface matt, stained yellow. Flesh turning yellow and in places reddish or bluish. Spores oval, slightly brown, $7 \cdot 5 \times 5\ \mu$. South Australia: Kuitpo, May, 1921. Vict.: Mr. E. J. Semmens has sent me (No. 73) what is from the dried specimens and his notes obviously the same species. He says: "Under Eucalypts (*E. melliodora*, Cunn.) and in long grass (*Poa caespitosa*, Forst., and *Anthistiria ciliata*, L.) and young growth of

E. elaeophora, F. v. M., Ararat, May, 1919. Whole plants at times with blood-red marks on the cap and in places on the pores and stem." Spores oval, nearly colourless, 7 to 8·5×5·2 to 6 μ.

Pileus 5·5 cm. latus, irregulariter convexus ad recurvatus, non-nitidus, flavus et ruber. Porae subparvae, peri stipem sulco, tubulae 6 mm. longae, sinapido-flavae., Stipes 2·5 cm. altus, 6 mm. crassus, subflavidus. Caro mutans flavidus et interdum rubidus vel cyaneus. Sporae ovales, subfuscae, 7·5×5 μ.

432. *Boletus portentosus*, Berk. and Br. Cke., Hand. Austr. Fungi, No. 563 (Vict.). An exceptionally large *Boletus* which we have met with in New South Wales, and recently also in South Australia, seemed from the description to be this Ceylon species already recorded as above for Victoria. To make certain as far as possible, I wrote in 1919 to Mr. T. Petch at Peradeniya, Ceylon, sending him some dried specimens. In replying he kindly furnished a copy of the original watercolour painting, which agrees very closely with the Australian specimens. The spores he found were similar, but noted that our plants appeared to be minutely tomentose (which is the case), whilst his notes on the Ceylon species stated that the pileus was glabrous. In Petch's redescription of this species (Annals Roy. Bot. Gdns., Peradeniya, iv., 1907, p. 58) the pileus is described as smooth and the stem as lacunose. He considers the dried type specimens of *Polyporus olivaceo-fuscus*, Berk. and Br., which the authors described with a pileus which was "pulverulento-tomentoso" as being immature plants of *B. portentosus*. It is probable, then, that young Ceylon plants are sometimes tomentose. With the exception of the lacunose stem, our plants thus agree remarkably well with Petch's description, and so we consider them to be *B. portentosus*, or at most an Australian variety.

A composite description of the Australian plants is as follows.—Pileus 11 to 15 inches (South Australian specimens) in diameter, convex to nearly plane, sometimes with the centre a little depressed, finely tomentose or flecked with brownish to greenish-brown fibrillose scales, tending to crack, brown with a greenish tinge or dingy yellowish olive (tints approaching Brown Pink, Dauthenay, pl. 297, ton 1, and browner than Bistre Green, pl. 296, ton 1). Flesh up to 2 inches thick, whitish but slightly dingy, sometimes turning yellowish with shades of sagey-green or bluish-green and around insect marks and sometimes in the stem reddish, soft in texture like firm cotton-wool and difficult to cut from its punkiness. Tubes ¾ to 1¼ inches long, just reaching the stem but leaving a slight sulcus, pinkish-orange-yellow or yellowish-green, becoming dark brown when old or injured (near Chrome Yellow, middle, Golden Yellow, pl. 26, ton 1, with reddish stains), orifices moderately large, rather irregular. Stem sometimes eccentric, up to 7½ inches long, very stout, up to 7 inches thick in the middle, 5½ inches thick above, bulbous, ending below in a short conical root, mouldy-looking green with tints of yellow and brown or dingy yellowish-brown (tints of Old Olive Green, Olive Brown, pl. 299, tons 1 and 2), darker below, punctate looking from groups of villosities, not reticulated. Spores obliquely elliptical or pear-shaped to oval, brownish, 7 to 8·5×5 to 6 μ. Taste mild. N.S. Wales: Chatswood, Feb., 1918 (Miss Clarke, Watercolour No. 175); National Park, March; Bulli Pass, April; Lisarow (C. H. Starkey), Oct.; Mount Irvine. South Australia: Bull's Creek (spores yellow-brown, elliptical, 8·5 to 9×5·6 μ).

433. *Boletus (Phaeoporus ?) lilacino-brunneus*, n. sp. *B. prunicolor*, Cke. and Mass., whose description this species somewhat resembles, has, if correctly described, much larger spores (18 to 20×6 μ). There is some resemblance also to the description of *B. intractus*, Fr. (Cke., Hand. Austr. Fungi, No. 564, W.A.), but the pores are hardly sulphur coloured. This species is common in places near Sydney and frequently remains long unexpanded. Pileus ¾ inch up to 3½ inches

in diameter in expanded specimens, convex, then slightly convex with the centre raised or irregularly plane, somewhat viscid when moist, when dry surface dull or finely villous and showing with a lens adpressed fibrils, sometimes splitting to show the white flesh, pale biscuit in colour to lilacy-brown, dull carnation or brownish-purple (browner than Lilac, Dauthenay, pl. 176, ton 4, with the edge Rosy White, pl. 8, ton 4; Dark Fawn, pl. 307, ton 4, to Burnt Umber, pl. 304, ton 2; deeper than Lilacy White, pl. 7, ton 4, flecked with Dark Chocolate Brown, pl. 342, ton 2). Pores adnate to adnexed and leaving a sulcus round the stem, then separating, minute, very crowded, dissepiments thick, the tubes very shallow, whitish to pale yellow or pale flesh (the tubes a deeper flesh) (Rosy White, pl. 8, ton 1, passing to ton 4 on bruising; Purplish-tinted White, pl. 6, ton 4; Amber White, Succinum (Yellow), pl. 12, ton 4). Stem 1¾ to 4 inches high, stout to moderately slender, up to 1 inch thick in the middle, base bulbous or a little swollen, solid, coloured like the pileus but not so dark and more streaky or sometimes punctate, dull carnation to lilacy-brown (browner than Lilac, pl. 176, ton 4; Purplish White, pl. 6, ton 4 above to Pinkish Neutral Tint, pl. 361, ton 1, below; near Fleshy White, pl. 9, ton 4, streaked with Dark Chocolate Brown, pl. 342, ton 3). Flesh thick, white, sometimes turning a little pink. Taste mild. Spores in the mass Lilacy White (pl. 7, ton 2), after keeping becoming browner with a purplish tint, microscopically pallid to brownish, mummy-shaped, sometimes deformed or long and narrow, 8·5 to 13×3·4 to 5 μ. N.S. Wales: Neutral Bay, Bradley Head, etc., round Sydney Harbour, Feb., March, April, May; Narrabeen, Newport (Dr. Darnell-Smith), March; National Park, March. A collection of expanded examples, apparently of this species, obtained at Bradley Head in April, had yellowish pores, turning bluish-green when bruised and the flesh of the pileus and stem turning yellow, then a rich blue (Pale Blush, pl. 137, ton 4; Maize Yellow, pl. 36, ton 4; Pale Ecru, pl. 66, ton 4; later blue). (Form. Sp., No. 75.)

Pileus 1·8 ad 8·7 cm latus, saepe non-expansus, convexus, deinde subconvexus vel irregulariter planus, subviscidus, exsiccatus subvillosus et adpresso-fibrillosus, lilacino-brunneus sed variabilis. Porae adnatae vel adnexae, peri stipem sulco, deinde disjunctae, minutae, dissepimentis crassis, tubulae perbreves, albidae vel roseo-albidae vel succineo-albidae. Stipes 4·5 ad 10 cm. altus, crassus ad subtenuis, base bulboso vel sub-bulboso, solidus, similis pileo coloratus, interdum punctatus. Caro crassus, albidus. Sporae lilacino-albidae, deinde subfuscae, fusiformes, 8·5-13×3·4-5 μ.

POLYPORUS.

434. *Polyporus pelles*, Jarvis. Lloyd, in Apus Polyporus, p. 327 (Q'land); Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, li., 1918, p. 528, No. 130. Syn. *P. atrohispidus*, Lloyd, Mycol. Notes, No. 58, March, 1919, p. 823. fig. 1376. Upper surface Russett (xv.) to Mars Brown (xv.) or near Bay (ii.) with paler areas, villous to hispid with brownish fibrils often in fascicles and sometimes scattered and showing the whitish fibrous surface below, nearly plane to slightly convex, up to 4½ inches broad by 3 inches antero-posteriorly. Contracted sometimes into a narrow, short, stem-like base, but usually broadly and somewhat decurrently attached by one-third or more of its border. Under surface convex. Pores minute, close, irregular, dissepiments thin, whitish, pallid or with a pale ochraceous tinge, when bruised or older turning Russet (xv.), the tubes when cut Pale Ochraceous Salmon (xv.), becoming Russet (xv.), occasionally ½ inch deep. Context radiately strigose, Pale Ochraceous Salmon becoming Russet, up to 1 inch thick at its attachment, gradually attenuating outwards. Flesh easily cut, softish but coherent. Spores abundant, elliptical, one side a little flattened,

white to pallid, some coloured brownish, 4·5 to 7·5 by 3·2 to 4 μ. On living and dead Eucalyptus trunks and stumps. N.S. Wales: National Park, May (identified by Lloyd, Nos. 183 and 523). South Australia: *Atrophispidus* form, on trunks of living *E. obliqua*, L'H., and on dead stumps, Mount Lofty, June and July (identified by Lloyd, No. 788), and National Park, Aug.; *pelles* form on *E. obliqua*, L'H., and dead stumps, Mount Lofty, May (identified by Lloyd, No. 789), and Kuitpo.

435. *Polyporus Victoriensis*, Lloyd. Lloyd (No. 846) has identified for us as this species plants found on a dead Eucalypt in the National Park, South Australia, in September, 1922. There were abundant subspherical whitish spores, 3·2 to 3·8 μ. No setae were seen. Lloyd has described our specimens as follows:—"Pileus sessile, large, 5×8 inches and 3 inches thick, ligneous, suggesting a *Fomes*. Surface with thin, pale, glabrous crust. Context brown. Pores about 1·5 cm. long, coarse to the eye, brown, the mouths darker. Setae none. Hymenial elements hyaline. Spores hyaline, globose, 4 μ, smooth." He considers our plant as a perfect specimen of the species he had previously described from Victoria on an imperfect specimen, and places the species in Sect. 95 of his Apus Polyporus, differing from the *P. gilvus* section (Sect. 96) in the absence of setae.

436. *Polyporus sordentulus*, Mont. N.S. Wales: Radiating from a common centre, on the ground, probably on an old stump, spores (?) 3·4 by 2 μ, Kendall, May (identified by Lloyd, No. 345).

437. *Polyporus concrescens*, Mont. N.S. Wales: Boatharbour, near Lismore, Aug. (identified by Lloyd, No. 417).

438. *Polyporus trabeus*, Fr. Placed by Lloyd in his Div. I., Sect. 81. N.S. Wales: On fallen trunk, National Park, May, spores rod-shaped, slightly curved, 3·5 to 4·2 by 1 μ (identified by Lloyd, No. 529, "in sense of my Apus Pamphlet"); on fallen trunk, Lisarow, when moist soft, white, surface a little dingy and rather velvety, pores do not change colour, spores numerous, white, 5·5 by 3·8 μ (identified by Lloyd, No. 455: "I make the spores allantoid").

439. *Polyporus rubidus*, Berk. Cke., Hand. Austr. Fungi, No. 640 (Q'land, N.S. Wales); Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, li., No. 12, N.S. Wales: Kendall, Aug. (identified by Lloyd, No. 565).

440. *Polyporus citreus*, Berk. Lloyd, Syn. Apus Polyp., p. 355: Lloyd, Letter 67, Note 659. N.S. Wales: National Park, July; Macquarie Pass, Aug. Identified by Lloyd (No. 422) with some doubt. He points out that the type at Kew is very small, and that he was in error in placing this species in Div. IV., Sect. 98, as the spores are evidently not coloured. He gives the colour of our specimens as Amber Yellow of Ridgway.

FOMES.

441 (iii., 185; iv., 305). *Fomes robustus*, Karst. Spores subspherical to rather triangular, hyaline, 6·3 to 8μ. Vict.: Staughton Vale, Brisbane Ra., Nov. (occasional narrow, acuminate, brown setae, 14·5 by 3 μ). South Australia: On *Eucalyptus viminalis*, Labill, Magill, June; National Park, Sept., and Kuitpo, May; on *E. ovata*, Labill., Kuitpo, March (two trees affected, one with a number of brackets and sick-looking), and between Willunga Hill and Myponga, Nov. (many trees affected); on *Casuarina stricta*, Ait., Encounter Bay, Jan. (occasional nearly colourless but slightly tinted oval spores, 9 by 7 μ, and occasional brown setae with swollen bases, 27 by 10 μ); at base of tree, Clare, Aug.; L. Bonney, S.E., Dec., and Port Lincoln, May; on *Callitris robusta*, R. Br., Kinchina, Sept.

442 (iv., 310). *Fomes rimosus*, var. *Casuarinae*, Clel. and Cheel. Spores subspherical to oval, brown, 6·5 to 7·5×4 to 5 μ. South Australia: On belah,

Casuarina lepidophloia, F. v. M., and on mallee, *Eucalyptus oleosa*, F. v. M., Renmark, Jan.; on *E. odorata*, Beh., Kinchina, Oct.; on *C. lepidophloia*, F. v. M., Oak Forest, Ooldea, Aug., and Dilkera, May (Prof. Osborn); on *C. stricta*, Ait., Clare, Aug.

443·(iv., 313) *Fomes (Ganodermus) applanatus*, var. *leucophaeus*, Mont We have recorded *F. applanatus*, Pers., for South Australia, but the form found in this State is probably this variety with a pallid crust. Mr. J. A. Hogan collected a large specimen (21 inches laterally × 8 inches × 3 inches thick) at the butt of an old pepper tree (*Schinus mollis*) at Burnside in April, 1924. The crust is pallid brownish to brownish, the context up to 1½ inches thick, and the pore layer ¼ to 1 inch thick. The latter for the most part shows evident seasonal additions to the tube length of small amount, though in one part a tube length of ¾ inches has been attained apparently in one growing period. These specimens are in obvious contrast to the usual New South Wales ones, with relatively scanty context and exceedingly long tubes (var. *australis*), the difference corresponding to the difference in rainfall (in total amount and seasonably distributed).

POLYSTICTUS.

444 (iii, 170; iv., 292). *Polystictus cinnabarinus*, Jacq South Australia: On peppermint gum, O'Halloran Hill, Aug. (G. H. Dutton); on dead stumps of *Callitris robusta*, R. Br., Murray Bridge, Sept., 1889 (Mr Zietz); on bunya-pine wood, *Araucaria Bidwilli*, Hook., Burnside, Aug. Western Australia: Kalgoorlie.

HEXAGONA.

445 (iv., 315). *Hexagona Gunnii*, Hook. Spores elongated, 16 to 24, usually 19×6·5 to 8 μ. South Australia: Hills above Glen Osmond, April; National Park, May; Mount Lofty, June; on *Eucalyptus viminalis*, Labill., Victor Harbour, Aug.

THELEPHORACEAE.

STEREUM.

446 (iii., 219; iv., 335). *Stereum membranaceum*, Fr South Australia: At base of *Casuarina lepidophloia*, F. v. M., Dilkera, May (Prof. Osborn).

CRATERELLUS.

447. *Craterellus multiplex*, Cke. and Mass. Cke., Hand. Austr. Fungi, No. 967 (Tas.). South Australia: At the base of a dead stump, Mount Lofty, June, upper surface of the pilei Light Pinkish Cinnamon (xxix.), the hymenial surface near Vinaceous Pink (xxviii.) of narrow thick radiating folds, sometimes forking or connected by bars.

GASTEROMYCETALES

PHALLOIDEAE.

448. *Phallus rubicundus*, Fisch., var. *gracilis*. Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, xlix., 1915, p. 199. Miss L. Greenberger, Head Teacher at Mount Benson School, near Kingston, S.E., has forwarded through Mr. A G. Edquist specimens of this species, collected in April and June in a sandy place amongst buffalo grass. The spores are rod-shaped, 5·5×2 μ. This is the first record of the genus for South Australia.

449. *Lysurus australiensis*, Cke. and Mass. Under the specific name of *L. Gardneri*, Berk., a Ceylon species, we have previously (Jour. Proc. Roy. Soc. N.S. Wales, xlix., 1915, p. 204) described a number of Australian plants. From

recent careful work by T. Petch it is clear that the Australian plant is a different species, and so we revert to Cooke and Massee's name, which in the above paper we suppressed as a synonym. N.S. Wales: In buffalo grass lawn, Narrabri, May, 1919; Palm Beach, April, 1918, lobes dirty orange South Australia: Plants up to 6 inches high. Arms 5, 1 inch long, upright but slightly spreading above, somewhat triangular, narrowing upwards, external surface Light Pinkish Cinnamon (xxix.) or Ochraceous Orange (xv.) and longitudinally grooved, the groove continuous with the stem, the inner surface covered with the dark brown gleba, more or less transversely rugose and the rugae occasionally anastomosing and encroaching on the sides of the external groove and passing between the arms, where the pileus is represented merely by a narrow rim, the arms hollow with the inner surface folded to correspond with the depressions in the outer surface. Stem attenuated downwards, tapering into the volva, ¾ inch thick below, ½ inch thick above, finely furrowed more or less longitudinally, leaving somewhat elongated depressions between the furrows, some of these penetrating deeply and forming slightly elongated lacunae, white below gradually passing into Cream Buff (xxx.) above, hollow with the cavity ¼ in in diameter and narrowed but open above and below, the wall of two layers of cells, the inner the larger. Volva white, lax, torn irregularly into lobes. Smell sickly faecal. Spores $4 \cdot 5 \times 2\ \mu$. On a lawn at the Grange, Jan., Feb, and April, 1924 (Mrs Kelly, per H. Finnis, Editor of the Journ. of Agric., South Australia).

NIDULARIACEAE.

Nidula.

450. *Nidula microcarpa,* Peck. Lloyd (The Nidulariaceae, 1905, p. 11) refers an Australian collection made by Reader, probably in Victoria, to this species (probably). We have found a single plant, which also seems referable to this species, between Bowral and Robertson, New South Wales, in August. The outer surface of the peridium is adpressed-tomentose and pallid. There are numerous, very small, dark reddish-brown peridioles, the surfaces of which are very slightly rugulose. The spores are 9 to $10 \cdot 4 \times 5 \cdot 5$ to $6 \cdot 8\ \mu$.

Cyathus.

451 (iv., 350). *Cyathus stercoreus,* Schw. N.S. Wales: Hawkesbury River, June, July. South Australia: On dung, Mount Lofty, May; by roadside, Green Hill Road, June.

452. *Cyathus vernicosus,* Tul. Clel. and Cheel, Proc. Roy. Soc. N.S. Wales, l., 1916, p. 107. Spores $9 \cdot 5$ to $12 \cdot 5 \times 4 \cdot 5$ to $8\ \mu$. Vict.: On decaying bark, Craigie, near Ararat, June (E. J. Semmens). South Australia: Adelaide, Feb. (A. H. C. Zietz); Mount Lofty, June; Islington, June (E. H. Ising); on fallen leaves and sticks, Beaumont, June (identified by Lloyd, No. 785) and July; New Brighton, Sept. (D. Gibbons).

453. *Cyathus Colensoi,* Berk. Lloyd, The Nidul., p. 26. South Australia: Lloyd (No. 790) has identified specimens for us collected by Dr. T. Campbell in August between Mount Eba and the North-South line. The outer surface of the peridium is whitish. In young specimens the adpressed hairs on the exterior are prominent. The spores are pear-shaped, $9 \cdot 6 \times 8\ \mu$. We have also collected specimens at Ooldea Soak in August; spores variable, $14 \cdot 5 \times 8\ \mu$, $9 \cdot 5\ \mu$, $9 \cdot 5 \times 6 \cdot 5\ \mu$.

ASCOMYCETALES.

454 (iii., 237). *Leotia marcida,* Pers. South Australia: Amongst leaves under trees, Mount Lofty, June, stem near Yellow Ochre (xv.), pileus near Medal Bronze (iv.). Spores slightly curved, 15 to 19×4 to $5\ \mu$.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA.
No. 22.

By J. M. Black.

[Read October 9, 1924.]

Gramineae.

Eragrostis interrupta, (Lamk.) Beauv. var. **tenuissima,** Stapf. Dr. Stapf distinguishes *E. interrupta* from *E. tenella,* (L.) Roem. et Schult., by the former having 2 stamens and the latter 3. Our far-northern grass (which also occurs in India and China) has only 2 stamens, and he therefore places it as above, instead of under *E. tenella.*

Eragrostis interrupta, (Lamk.) Beauv var. **densiflora,** n. var. Variat paniculâ erectâ spiciformi 6-10 cm. longâ basin versus interruptâ, ramis 5-20 mm. longis dense fasciculatis et secus rhachin principalem appressis usque ad basin spiculis vestitis, spiculis subsessilibus 2-3 mm. longis 4-5-floris, glumâ floriferâ 1 mm. longâ, paleâ glabrâ, staminibus 2, caryopsi ovoideâ nitente ½ mm. longâ.

Toorawatchy Waterhole, between Cordillo Downs and Innamincka; coll. J. B. Cleland. Has a very different appearance from var. *tenuissima* because of the compact spikelike panicle, with appressed branches shorter and much more densely clothed with spikelets.

Isachne australis, R. Br., has been found by Professor Cleland at Black Swamp, near Currency Creek.

Cyperaceae.

Cyperus Eragrostis, Vahl., has been re-discovered by Professor J. B. Cleland in a marsh near the Bluff, Victor Harbour.

Var. **pauperata,** n. var. Variat caule tantum 1-3 cm. longo verisimiliter annuo tantum 1 vel 2 spiculas gerente, involucri bracteis 2, alterâ breviore alterâ multo longiore quam spicula.

Spring behind the Bluff; coll. J. B. Cleland. Our specimens show a minute plant, with spikelets of the type, but much reduced in number.

Cyperus Clelandii, n. sp. Perennis, caule subrobusto 50-80 cm. longo apicem versus trigono, foliorum vaginis latis scariosis laminis angustis caulem subaequantibus margine scabris, umbellae compositae radiis primariis circiter 8 3-10 cm. longis, radiis secundariis alternis divergentibus inaequalibus base bracteatis apice 3-10 spiculas glomeratas stellatim patentes gerentibus, spiculis linearibus compressis aureis 6-9 mm. longis 2 mm. latis 8-12-floris, involucri bracteis circiter 5 quarum 3 vel 4 inflorescentiam longe superantibus, glumis 2 mm. longis mucronulatis utroque latere 3-4-nerviis, rhachillâ diu persistente angustissime alatâ, nuce angustâ trigonâ acutâ stramineâ sub lente granulatâ glumae fere aequilongâ.

Cordillo Downs, north of Cooper Creek; fruiting May, 1924. Named after the finder, Professor J. B. Cleland, who made a large collection of plants in the Far North-East during May and June, 1924. Differs from *C. longus,* L., *C. rotundus,* L., *C. tuberosus,* Rottb., *C. stolonifer,* Retz., and *C. disruptus,* C. B. Clarke, in the nut nearly as long as the fruiting glume, instead of only ⅓ or ½ as long. In other respects it comes nearest to descriptions of *C. tuberosus,* but the spikelets are shorter and fewer-flowered, the glumes much shorter and distinctly 3-4-nerved on each side. The ripe glumes are caducous from base of rhachilla; the rhizome

is unknown. From *C. laetus,* C. B. Clarke, it differs in the nut narrowly elliptic and acute, not obovoid, in the compound umbels and fewer-flowered spikelets

Bulbostylis capillaris, (L.) C B. Clarke.—Synonym *Fimbristylis capillaris,* (L.) A. Gray.

North of Cooper Creek, coll. J. B. Cleland. First record for South Australia

Schoenus fluitans, Hook. f., has been found near Encounter Bay by Professor Cleland

CHENOPODIACEAE.

Bassia uniflora, F. v. M. var. **incongruens,** n. var. Variat praecipue semine fere verticali, foliis 7-15 mm. longis, spinis tenuibus 2-5 mm. longis, perianthii basi cavâ obliquiore.

Flinders Range and the Far North.—This is the form mentioned by Mr. R. H. Anderson in his Revision of the genus *Bassia,* in Proc. Linn. Soc. N.S Wales, 48; 329 (1923), as having been found at Hergott and on the Arkaringa Creek It occurs also north of Cooper Creek and seems worthy of at least varietal rank. The vertical seed brings it near *B. parallelicuspis,* R. H. Anderson, but in general appearance it is nearer *B. uniflora.* It differs from *B. parallelicuspis* in the longer and divergent spines, and from *B. uniflora* in the vertical seed and the fruiting perianth less expanded at summit and with a somewhat more oblique base.

AMARANTACEAE.

Trichinium helipteroides, F. v. M. var. **minor,** n. var. Variat parvitate omnium partium, foliis late lanceolatis circiter 1 cm longis, spicis globosis 8-10 mm. diam. breviter pedunculatis, bracteolis bracteam fere aequantibus, perianthio 5 mm. longo.

Blood Creek (N. of Oodnadatta); coll. S. A. White. Has somewhat the aspect of *Helipterum moschatum.*

RANUNCULACEAE.

Ranunculus parviflorus, L., var. **glabrescens,** n. var. Forma fere glabra, foliorum segmentis petiolulatis lobulatis, petalis interdum 6, achaeniis tuberculatis breviter rostratis.

Reedbeds, near Adelaide; River Murray; Flinders Range.

LEGUMINOSAE.

Swainsona villosa, n. sp. Planta tenuis humilis pilis simplicibus villosa praesertim in partibus junioribus, foliolis 5-7 obovato-cuneatis 1-1½ cm. longis supra glabrescentibus, stipulis lanceolatis, floribus purpureis circiter 5 in racemo pedunculato, bracteis pedicellis fere aequilongis, calyce 6 mm. longo pilis nigris villoso, dentibus acuminatis tubum saltem aequantibus, bracteolis minutis, vexillo circiter 15 mm. lato ecalloso, carinâ obtusâ alis aequilongâ, ovario villoso, stylo usque ad medium barbato, apice recto post stigma penicillato, legumine ignoto.

Glen Ferdinand, Musgrave Range; coll. S. A. White. Differs from the following in the colour of the keel and the small tuft of hairs behind the stigma, not all round it; also in the style straight towards the summit. The other long-haired species are without hair-tufts near the stigma.

Swainsona flavicarinata, n. sp. Planta prostrata griseo-viridis pilis simplicibus villosa, foliolis 5-9 obovato-cuneatis vel oblongo-cuneatis 6-15 mm. longis utrinque pilosis vel supra glabrescentibus, stipulis anguste lanceolatis, racemo 6-12-floro, bracteâ longiore quam pedicellus brevis, calycis 8 mm. longi dentibus lanceolato-subulatis tubo longioribus, bracteolis tubum aequantibus, vexillo rubro circiter 12 mm. lato, ungue incrassato, alis rubris brevioribus quam

carina flava incurva, stylo complanato totâ longitudine barbata, apice fere directi-angulatim inflexo circum stigma penicillato, legumine ovoideo-oblongo compresso villoso 5-14 mm. longo secus suturam impresso.

Near Lake Torrens; along Broken Hill railway; Strzelecki Creek; near Great Bight; western New South Wales; Barrow and Fraser Ranges (Western Australia). Differs from the other long-haired species by the style abruptly bent inwards near the summit, not merely hooked. The yellow keel is always conspicuous.

Swainsona reticulata, n. sp. Planta humilis pilis simplicibus appressis pubescens, foliolis 5-9 oblongo-cuneatis vel oblongo-linearibus obtusis vel emarginatis, stipulis lineari-lanceolatis, racemo 2-6-floro, bracteis pedicello saepius aequilongis, calycis 5-6 mm. longi dentibus saepe acuminatis, bracteolis minutis, vexillo 10-12 mm. lato base parum calloso vel ecalloso, carinâ obtusâ alis aequilongâ, ovario pubescente, stylo totâ longitudine barbato, apice directi-angulatim inflexo sine penicillo, legumine subcylindrato 15-20 mm. longo 3-4 mm. lato nervis eminentibus reticulato pubescente secus suturam profunde impresso biloculato.

Murray lands; Wynbring; Musgrave Range; between Ooldea and Great Bight; Lake Victoria (New South Wales). Near *S. oroboides*, but differs in the cylindrical non-inflated 2-celled pod, the obtuse leaflets and the flowers in a short raceme.

Swainsona campestris, n. sp. Planta rigidula pilis simplicibus appressis pubescens, foliolis 5-11 linearibus vel lineari-lanceolatis acutis 1-2 cm longis, stipulis longis subulatis, floribus purpureis 4-8 in racemo, bracteâ breviore quam pedicellus, calyce 5 mm. longo nigri-pubescente, dentibus lanceolatis tubo brevioribus, bracteolis minutis, vexillo circiter 10 mm. lato ecalloso, carinâ obtusâ alas subaequante, pedunculis fructiferis elongatis rigidis patentibus, stylo totâ longitudine barbato, apice recto, legumine subcylindrato villoso 12-20 mm. longo circiter 4 mm. lato secus suturam profunde impresso biloculato apicem versus saepe incurvo.

Hughes Railway Station (Nullarbor Plain); coll. E. H Ising. Differs from the preceding in the straight style, the acute leaflets, the long rigid fruiting peduncles and the less prominently reticulate pod

Swainsona viridis, n. sp. Planta viridis prostrata fere glabra, foliolis 7-11 obovatis nonnunquam emarginatis vel fere obcordatis 5-10 mm. longis margine et nervo medio pilosulis, stipulis magnis foliaceis obtusis semicordatis, floribus purpureis 5-8 in racemo, bracteis foliaceis ovato-lanceolatis ciliolatis pedicello brevi longioribus, calyce 7 mm. longo glabro absque dentibus lanceolatis ciliolatis tubum aequantibus, vexillo circiter 15 mm. lato ecalloso, carinâ obtusâ alis sublongiore, bracteolis lanceolatis tubo calycis fere aequilongis, ovario pubescente, stylo totâ longitudine barbato apicem versus recto, legumine ignoto.

Curnamona Station (north of Yunta Railway Station); coll. T. G. B. Osborn. A handsome species owing to the bright flowers and green foliage; well distinguished from *S. campylantha* and other species by the broad leafy stipules, bracts and bracteoles.

Swainsona microcalyx, n. sp. Planta gracilis ascendens pilis minutis appressis centraliter affixis puberula, foliolis 3-9 oblongo-cuneatis vel obovato-cuneatis obtusis vel emarginatis supra glabrescentibus 5-12 mm. longis, stipulis lineari-lanceolatis, floribus parvis purpureis 12-20 in racemo rigidule sed graciliter pedunculato, bracteâ pedicello breviore, calyce 3 mm. longo, dentibus 1 mm. longis, bracteolis minutis, vexillo circiter 8 mm. longo latoque ecalloso, alis carinae obtusae aequilongis, stylo tenui totâ longitudine barbato apicem versus recto, legumine non bene maturo subcylindrato appresse puberulo 17 mm. longo 3-4 mm. lato.

Tarcoola; coll. E H. Ising. This species belongs to the section with forked hairs attached by their centre. It differs from other members of the section in the smaller, more numerous flowers; the long stiff peduncles resemble those of *S. campestris* but are much more slender.

Swainsona stipularis, F. v. M. (1852). This is the valid name of this species, as *S. phacifolia*, F. v. M. (1850) is a *nomen nudum*. The latter name was published, without any description, in a letter to the editor of the *South Australian Register*, signed "Dr. Ferdinand Mueller," and printed in the issue of 19th Feb., 1850. In the course of the letter Mueller wrote:—"To the already known kinds of the beautiful *Swainsonia (sic)*, my researches add three new ones, very valuable in horticulture, *S. phacaefolia, S viciaefolia, S. Behriana*"

Pultenaea dentata, Labill Mount Compass First record for South Australia.

Glycine sericea, (F. v. M.) Benth., var **orthotricha**, n. var. Variat pilis appressis erectis (non reflexis ut in typo et in ceteris speciebus nostris), seminibus ovoideo-oblongis nonnunquam maculosis.

Alberga River, coll. H W. Andrew; Central Australia, coll. R Tate

Indigofera enneaphylla, L. Cordillo Downs (north of Cooper Creek); coll J B. Cleland. First record for South Australia.

Cassia Sturtii, R. Br., var. **planipes**, n. var. Variat foliis 3-jugis ovato oblongis 12-20 mm longis, petiolo ad perpendiculum complanato canescente, antherâ infimâ ceteris sublongiore, legumine 5-9 cm. longo 12-19 mm lato

Cordillo Downs; coll. J. B. Cleland.

Tephrosia sphaerospora, F. v. M.—Between Cordillo Downs and Cooper Creek; coll. J B Cleland First record for South Australia.

Zygophyllaceae.

Zygophyllum compressum, n. sp. Planta annua erecta, foliolis ovatis vel orbicularibus aut supremis oblongis 8-15 mm. longis, altero foliolo alterum adversum aspectante (non utroque in codem plano divergente ut in ceteris speciebus), petalis 4 flavis apice rotundatis 4-6 mm, longis duplo longioribus quam sepala, staminibus 8, filamentis alatis et leviter bidentatis, disco in 4 glandulas erectas lineari-oblongas truncatas ovarium subaequantes apice ciliolatas diviso, capsulâ obovoideâ nutante 7-10 mm. longâ basi et apice 4 angulis rotundatis instructâ, seminibus 2-3 in quoque loculo.

Port Augusta to near Fowler Bay; Far North; Central Australia. The small flowers and capsules and the leaflets turned inwards so as to face each other distinguish this species from *Z. glaucescens*.

Zygophyllum tesquorum, n. sp. Planta annua ascendens, foliolis oblique oblanceolatis vel oblongo-ellipticis 6-10 mm. longis integris, petalis 5 in siccitate albis circiter 6 mm. longis duplo longioribus quam sepala, staminibus 10, filamentorum dimidio inferiore dilatato sed non alato, capsulâ globosâ 6-7 mm. longâ 5-angulatâ in pedunculo filiformi patente vel deflexo 7-10 mm. longo, semine haud nitente 1 in quoque loculo.

Lake Torrens; Far North; Central Australia. Near *Z. iodocarpum*, differing in the much longer petals and peduncles and in the dull seeds. This and the preceding species belong to the section *Roepera*.

Tremandraceae.

Tetratheca halmaturina, n. sp. Suffrutex humilis fere glaber, caulibus teretibus rigidis junciformibus glandulis sessilibus conspersis, foliis ad paucas squamas minutas subulatas reductis, flore breviter pedunculato in axillâ bracteae subulatae, petalis rubris vel albidis 9-13 mm. longis, tubo antherino antherae fere

aequilongo, ovario apicem versus puberulo, ovulo 1 in utroque loculo, capsulâ obovato-cuneatâ, seminibus puberulis.

Kangaroo Island. Near *T. juncea*, Sm., but differs in the stems with sessile glands and without acute angles or wings, the sepals and petals 5 instead of 4, the longer anther-tube and the single ovule in each cell. From the Western Australian species it differs in the pubescent seeds.

EUPHORBIACEAE.

Phyllanthus thymoides, Sieb., var. **parviflorus,** n. var. Fruticulus, ramulis pilis minutis patentibus sparse vestitis, foliis obovato-cuneatis apice fere truncatis 3-6 mm. longis glabris absque margine ciliato, sepalis masculis ovatis 1 mm. longis ciliolatis, antheris subsessilibus liberis, filamentis brevissimis liberis et glandulis minutis suffultis.

Near Wolseley; also in the Victorian Tatiara. Varies from the type in the smaller flowers, the shorter filaments always free and the minute glands at their bases.

BORRAGINACEAE

**Heliotropium supinum*, L. Blanchetown, River Murray; coll. A. Morris.—Mediterranean region. Apparently the first time this weed has been recorded in Australia.

COMPOSITAE.

Pluchea rubelliflora, (F. v. M.) n. comb., is described by Bentham as "glabrous" and by Mueller (Rep. Babb. Exped., 11) as "sometimes glandular-downy and hispid." The latter statement is confirmed by the specimens we have from Cordillo Downs, Strzelecki Creek, and Flinders Range.—*Eyrea rubelliflora,* F. v. M., in Linnaea, 25: 403 (1852); *Pluchea Eyrea*, F. v. M. Rep. Babb. Exped. 12 (1859).

A MONAZITE-BEARING PEGMATITE NEAR NORMANVILLE.

By R. Grenfell Thomas, B.Sc.

[Read October 9, 1924.]

Plates XXIII. and XXIV.

The pegmatite formation described in this paper is situated in Section 219, Hundred of Yankalilla, about 4½ miles south-west of Normanville. The oldest rocks of this area are highly altered sediments which are traversed to a considerable extent by intrusions of syenitic and granodioritic pegmatite, varying in width from a few inches to several feet. The metamorphism which these sediments have undergone has been chiefly of a regional-dynamic type resulting in the production of quartzose schists and mylonised grits in which the original sedimentary structure is, for the most part, easily seen. Thermal contact metamorphism resulting from the pegmatite invasions is also noticeable, especially where the igneous dykes are of large dimensions or are injected on a *lit-par-lit* system. The most obvious result of this thermal metamorphism has been a more or less complete recrystallisation of the schistose grits in immediate proximity to the pegmatite bodies. The rock types formed in this way are very variable, but are often micaceous or sericitic schists; occasionally there is evidence of partial assimilation of the sediments by the igneous rock.

The strike of this complicated series of metamorphic rocks, though subject to small variations, is approximately N. 50° E.,(1) which is roughly parallel to the sea coast in the vicinity. The dip of the beds averages 35° towards S. 40° E. The direction of strike and dip account to some extent for the bold and precipitous cliffs—often almost 300 feet in height—which mark the scarp face of these beds, and which form such a conspicuous feature of the coastal scenery to the south of Normanville.

The age of this series of metamorphic rocks, on a stratigraphical basis, cannot as yet be fixed with any certainty. They have been provisionally classed as "Barossian," the evidence being chiefly based on structural and mineralogical similarities, for as yet the stratigraphical relationship between the Normanville schists and the Adelaide Series has not been finally determined. As will be shown in a later section of this paper, on criteria of radioactive disintegration, the age of the monazite, deduced from the lead-thorium ratio, is so great as to imply at least an early Proterozoic age for the rocks with which it is associated.

Particulars of the Pegmatite.

As previously stated, the pegmatite in which the monazite occurs is situated in Section 219, Hundred of Yankalilla. The formation outcrops in the angle of the cliffs formed by the sea and the "Little Gorge" at a height of almost 200 feet above sea level. It is best exposed on the seaward cliff, where it extends for at least 70 feet with a thickness varying from 2 feet up to about 15 feet. The outcrop on the slope facing the "Little Gorge" is not so well exposed, but can be traced intermittently for a greater distance. The width of the body on this slope is also very variable.

The dip is 40° towards S. 30° E., and the strike is N. 60° E., so that the pegmatite is approximately conformable to the dip and strike of the metamorphic rocks in which it occurs.

(1) All bearings are given with reference to magnetic north.

The main body of the pegmatite is composed of a medium-grained, light-coloured, felspathic rock containing a considerable amount of bluish quartz, and in many instances there is a decided tendency towards a graphic intergrowth of the quartz and felspar.

Microscopical examination reveals the fact that the rock is closely allied to the grano-diorites and their pegmatitic differentiates, orthoclase being almost entirely absent, while the bulk of the felspar is albite. A dusty decomposition of the felspar is very noticeable, even in the freshest material obtainable. Strain structures are very strongly developed in both the quartz and felspar, both of which show a marked shadow extinction, while the twinning lamellae of the felspar are often bent. Evidence of dynamic metamorphism is also afforded by patches of granular quartz and felspar, most of which are clearly derived from the original minerals by crushing. The chief accessory mineral present in the slide is apatite, which is relatively plentiful as minute colourless prisms included in the felspar and less frequently in the quartz. Sphene and rutile grains are occasionally present, while secondary chlorite is sometimes rather common.

The ferro-magnesian component of the magma is represented by a remarkable type of biotite mica, the nature of which will be discussed later. This mica is confined almost exclusively to the borders of the pegmatite, where it forms large sheets up to a foot or more in diameter and of considerable thickness. These sheets are devoid of crystal outline and are generally bent and fractured; they are best developed on the hanging-wall of the formation. On the footwall there is a marked tendency for the mica to pass into a fine-grained black aggregate, and it is in this matrix that the two chief accessory minerals of the pegmatite —rutile and monazite—are typically developed.

The rutile is present in sufficient quantity to constitute an important ore body; its presence has been recognised for a number of years and it has been mined to some extent from time to time. The Deputy Government Geologist (R. Lockhart Jack) reported in 1921 on the possible commercial value of the deposit and briefly described the mode of occurrence of the rutile.[2]

It was then estimated that about 18 tons of hand-picked rutile had been mined. As the existence of the monazite was not suspected, it is certain that a considerable amount of this mineral was present in the rutile disposed of, and would probably have enhanced the value of the ore had its presence been recognised. Mining operations have now been suspended for a number of years, although a fair amount of rutile is still visible in the pegmatite body.

Mode of Occurrence of the Rutilf and Monazite.

The habit of the rutile so closely resembles that of the monazite that remarks on the occurrence of one mineral may, for the most part, be satisfactorily applied to the other. It must, however, be borne in mind that the rutile is largely in excess of the monazite, for whereas the rutile is present throughout the greater part of the formation which is exposed, the monazite, so far as could be determined, is confined chiefly to the outcrop on the seaward slope. The two minerals are typically developed as lenses or "augen," which have their longer axes parallel to the direction of schistosity of the country rock. These lenses are, for the most part, surrounded completely by biotite, but occasionally there is a local development of quartz enclosing the mineral; this is more noticeable in the case of the rutile than the monazite.

It may also be mentioned that in some instances the rutile is present as irregular segregations in the felspathic rock itself; the monazite, however, was

(2) The developments which exposed the monazite were made subsequently to Mr. Jack's visit.

not observed to occur in this manner. The lenses of rutile are very variable in size, the largest being almost 2 feet across and 8 inches in diameter, but the bulk of the material is considerably smaller in size. In the case of the monazite, the largest homogeneous specimen collected by the writer measured 6 inches long by 4 inches wide and 3 inches thick, the weight being approximately 4 lbs. Another specimen, apparently not quite homogeneous, weighed 5½ lbs. In proportion to the size of the pegmatite body these specimens are certainly remarkably large.

Although the monazite may not prove to be widely developed throughout the formation the concentration in certain parts is very great. In support of this, it may be remarked that the writer was able to collect on various occasions a total weight of approximately 100 lbs. of the clean mineral.

The monazite and rutile are seldom found associated in one nodule, but when this does occur the boundaries of either mineral are invariably sharply defined and show no definite evidence of the order of consolidation.

Particulars of the Monazite.

When in the matrix the monazite so resembles the rutile that it is only with difficulty that the two can be identified; on a freshly fractured surface, however, the many differences are at once apparent. With the exception of two individual crystals all the monazite collected was of the massive variety, very compact in texture and with no tendency to granular aggregation.

The colour on a freshly broken surface ranges from light reddish-brown through clove-brown to a deep chocolate. With the exception of the chocolate-coloured material, which generally has sharply defined boundaries, the other variations in colour merge imperceptibly. The lustre is distinctly resinous. The mineral is typically opaque in the hand specimen, but occasionally the thinnest edges of the freshest material are sub-translucent.

The specific gravity varies from 4·84 to 4·95 in the fresh mineral, the majority of the specimens corresponding to the highest figure.

The specific gravity falls off rapidly in the altered varieties.

The hardness, though somewhat variable, is approximately 5, and the mineral is somewhat brittle.

Macroscopic inclusions, irrespective of rutile, are chiefly confined to veinlets of quartz and biotite. These veins are rather plentiful and are generally roughly parallel to each other. They represent strain structures formed subsequently to the consolidation of the monazite and filled with residual magmatic products. They are always disposed at right angles to the plane of schistosity of the micaceous matrix, and the quartz filling them is generally somewhat fibrous.

Cleavage is seldom observable in hand specimens, and when it does occur it is but poorly developed. Weathered specimens are devoid of resinous lustre and often have an ochreous texture and colour. The high specific gravity is lost and in the final stages the mineral presents a cellular clayey appearance and is permeated by reddish patches and streaks.

Euhedral Crystals of Monazite.

Monazite showing a definite crystal form is of rare occurrence in the pegmatite, and the writer was able to obtain only two imperfect specimens. These were found embedded in the decomposed micaceous matrix, and are themselves so altered on the crystal faces as to render them useless for goniometric measurements. So far as can be determined they exhibit the tabular monoclinic symmetry characteristic of monazite.

The larger crystal shows at least seven well-defined faces and has the following dimensions:—

Length	.. .. ..	4 cms.
Width	.. .. ..	2·25 cms.
Thickness	.. .. ..	1·25 cms.

The weight is 24·5 grams.

The smaller crystal shows at least 12 faces and weighs 15·5 grams. Its dimensions are:—

Length	.. .. ..	2·75 cms.
Width	.. .. ..	2 cms.
Thickness	.. .. ..	1·5 cms.

Microscopic Features of the Monazite.

Several thin sections of the monazite were prepared for petrological examination, and these reveal features which are not apparent in the hand specimen. In slides of the order of ·03 mm. in thickness the fresh mineral is quite transparent and ranges from colourless to faint yellow, but it is traversed in all directions by an irregular network of brown semi-opaque material which appears to be amorphous. The microscopical structure closely resembles that of a partially serpentinised olivine rock. Most of the brown amorphous material is clearly an alteration product of normal monazite and probably represents the hydrated oxides of the rare earth metals. Its formation, as in the case of olivine changing to serpentine, has been accompanied by an expansion which has produced radially disposed cracks around certain irregular nuclei, and along these cracks the alteration has proceeded.

The unaltered mineral is distinctly homogeneous so far as can be determined from its optical properties, though variations in the thorium content are revealed by other tests and will be discussed later.

Some of the dark patches show very strongly defined edges, a fact which suggests that they may represent residual structures of a crystalline mineral more susceptible to alteration than the normal monazite. There is some evidence in favour of this view which will be discussed in connection with the radioactivity of the mineral.

The refractive index and birefringence of the unaltered mineral are both high. Pleochroism is not noticeable except in thick sections. The mineral is optically continuous over relatively large areas and does not show any marked strain shadows under crossed nicols.

With regard to the veinlets of decomposed brown material it may be noted that these pass without interruption through the quartz and biotite veins included in the mineral, and are thus clearly secondary alteration features.

Analysis of the Monazite.

The material selected for chemical analysis was the freshest obtainable broken from the centres of large specimens and freed from any mechanically mixed quartz and rutile by attracting it to a strong electro-magnet. The method of analysis followed was the usual procedure of decomposing the finely powdered mineral with hot sulphuric acid and subsequent precipitation of the rare earth oxalates from the aqueous extract. Thorium was estimated by precipitation of the hydrated oxide from a neutral nitrate solution by hydrogen peroxide and the result checked by the more usual thiosulphate method.

No attempt was made to separate the individual rare earths of the cerium and yttrium groups, as this cannot be done with quantitative accuracy. The other constituents were determined by the standard methods.

Statement of Analysis.

Phosphorus pentoxide (P_2O_5)	26·88
Cerium oxide (Ce_2O_3)	25·09
Lanthana and Didymia (La_2O_3, Di_2O_3, etc.) ..	24·32
Thorium oxide (ThO_2)	10·70
Yttria and Erbia (Y_2O_3, Er_2O_3, etc.)	4·00
Calcium oxide (CaO)	2·60
Titanium oxide (TiO_2)	1·70
Silica (SiO_2)	1·65
Ferric oxide (Fe_2O_3)	·85
Lead oxide (PbO)	·55
Water at 110° C.	·40
Water and gases above 110° C.	1·52
Total	100·26

Discussion of the Analysis.

As might have been anticipated from the general appearance of the mineral, the analysis reveals a monazite of unusual and interesting composition. The high percentage of thoria is perhaps the most striking point, especially as the monazites hitherto recorded in South Australia have been abnormally poor in this constituent.

The relatively high percentage of calcium and titanium suggests the presence of sphene, but as this mineral has not been observed as inclusions in the monazite its presence cannot be definitely established. In any case the thorium, if combined partly as silicate, in which form it is thought to exist in monazite, would still be unsatisfied by the available silica, and thus preclude the existence of sphene. Moreover, since the calcium and titanium oxides are not in the correct ratio to form the perofskite molecule, they are probably to be taken as essential constituents of this particular monazite.

The rare earths of the yttrium group are well represented, and must also be regarded as forming part of the complex monazite molecule since there are no obvious inclusions of xenotime or other yttrium minerals.

In view of the fact that monazite is normally one of the anhydrous phosphates group, the relatively high percentage of combined water is especially significant as showing the alterations that the mineral has undergone. The change is probably to be interpreted as a partial hydration of the rare earth bases with simultaneous leaching of phosphoric acid; this argument is supported by the microscopic structure of the mineral when examined in thin sections.

Uranium is either absent or exists in such minute amount as to be impossible of detection by the usual analytical methods. If it is entirely absent the lead must be regarded solely as a degradation product of the thorium series.

Niobium and tantalum were especially tested for, since the presence of minerals of the fergusonite or samarskite groups might reasonably be suspected in a pegmatite formation so rich in titanium and rare earths; both, however, were absent. Aluminium was also proved to be absent.

Age of the Monazite from the Lead-Thorium Ratio.

Although the material analysed was not absolutely free from alteration, it was considered desirable to establish the approximate age of the mineral from the ratio of the lead to the thorium.

The following formula, for which the writer is indebted to Prof. L. Cotton, of Sydney University, was used:—

$$\text{Age} = \frac{\text{Pb.}}{\text{Th.} + \cdot 56 \text{ Pb.}} \times 2065 \times 10^7 \text{ years.}$$

Pb. represents the percentage of metallic lead and Th. the percentage of metallic thorium, as found by chemical analysis

The analysis gave: $\cdot 55\%$ PbO $= \cdot 51\%$ Pb.
$10\cdot 70\%$ $ThO_2 = 9\cdot 40\%$ Th.

Therefore we have:

$$\frac{\cdot 51}{9\cdot 40 + (\cdot 56 \times \cdot 51)} \times 2065 \times 10^7 \text{ years}$$

i.e., 1,073 million years (approx.).

From the extreme age of the mineral, and consequently of the rocks with which it is associated, it is evident that the formation must be regarded as of, at least, Lower Proterozoic age.

Radioactivity of the Monazite.

The high thorium content of the monazite is responsible for a marked radioactivity of the mineral which may be demonstrated by its effect on a photographic plate or a sensitive ionisation electroscope. A well-defined scintillation is also obtained when the mineral is exposed to the fluorescent screen of a scintilloscope.

When a polished face of the mineral is placed on a photographic plate wrapped in opaque paper, and left undisturbed in a light-tight box for several days, the plate, on development, shows a strongly defined impression of the mineral. The impression is, however, not of uniform intensity and shows irregular patches of higher activity distributed through the normally active material. These patches of superior activity were found to correspond in general, to the darker portions of the mineral, and especially to the chocolate-coloured variety. It thus becomes evident that the thorium is not uniformly distributed throughout the mineral, although petrological examination reveals no appreciable difference in the optical properties of the light and dark coloured varieties. In this connection it should be noted that those portions of the mineral which macroscopically appear dark are seldom dark coloured in thin section, and are in general quite distinct from the semi-opaque brown decomposition material which is such a typical feature of the mineral as seen under the microscope.

In one specimen the dark coloured and highly active material was observed to be enclosed by well-defined boundaries which appeared to have originally been crystal faces (see pl. xxiii., fig. 2), but usually the distribution is quite irregular.

The rate of discharge of a sensitive ionisation electroscope by the mineral was found to be about two and a half times as great as that produced by an equal amount of Brazilian monazite sand known to contain approximately 4 per cent. of thoria. This test, therefore, roughly confirms the percentage of thoria obtained by analysis.

The insoluble residues, consisting principally of silica and lead oxide, obtained in the course of a bulk analysis of the ore, still showed a marked radioactivity, notwithstanding the fact that they contained no thoria or unaltered ore. This fact must be attributed to the presence of a small amount of the highly active substance, mesothorium, which would naturally tend to concentrate in the insoluble residues.

The Rutile.

The macroscopic structure of the rutile is typically massive, and in no instance does it show any tendency to form distinct crystals. In many cases it is not so compact as the monazite, but this feature is largely due to the shattering effect of dynamic metamorphism. The cleavage, when shown, is much interrupted and the fracture is very rough. The colour varies from a typical dark red to almost black and the lustre is occasionally sub-metallic.

An iridescent tarnish is very common, but this alteration is purely superficial and weathering in the normal sense is entirely absent. The mineral is quite opaque in the hand specimen. Macroscopic inclusions are chiefly confined to quartz, but are not common.

Microscopic Structure.

The microscopic structure is somewhat complicated owing to the presence of two types of twinning, one normal, the other in part polysynthetic. The cleavage is also well shown. The colour varies from reddish-brown to yellow, partly according to the thickness of the slice and partly on account of well-defined areas of variable composition. Ilmenite is a rather common inclusion, especially in the dark-coloured varieties, where it often forms small veins traversing the mineral. It also occurs as a dusty aggregate following the cleavage cracks, and in this form appears to be secondary.

The refractive index and birefringence are both characteristically high, while the pleochroism is not strongly marked. Optical continuity over large areas is a common feature.

Composition of the Rutile.

Several partial analyses of the rutile were made, primarily to determine if it contained any rare earths or other abnormal constituents. The analyses, however, revealed a variation from 95 to 98 per cent. of titanium dioxide, the remainder being chiefly iron with a little silica and a strong trace of vanadium.

The presence of vanadium is noteworthy, although the wide distribution of traces of this element in ilmenite, rutile, and other titaniferous minerals is now recognised. As might be expected, the darker varieties of the rutile contain the most iron; they are also richer in vanadium than the lighter-coloured types. No trace of radioactivity could be detected in any of the varieties.

The Biotite Mica.

The biotite mica associated with the pegmatite is, on account of its microscopic structure, one of the most remarkable types yet recorded from South Australia.

Its mode of occurrence has already been referred to in the general description of the pegmatite. In macroscopic appearance the mica is a greenish-bronze colour and occasionally shows a reddish tinge; the lustre is nacreous. It is quite opaque in the hand specimen.

The basal cleavage is perfect, as usual, and the laminae so obtained are flexible but quite inelastic. The "books" are generally considerably bent and cross fractured and lack a definite crystal outline.

In weathering, the mica first tends to lose its dark colour and becomes "greasy" to the touch. In the final stages it passes to a fine-grained flaky aggregate closely resembling talc. There is a considerable development of this talcose material in certain parts of the formation.

Microscopic Features.

When microscopically examined in very thin sections cut parallel to the basal plane, the mica shows a most extraordinary development of rutile inclusions. These are arranged in the form of a continuous sagenite web which exhibits a very remarkable degree of symmetry and regularity. The individual needles are exceedingly thin but attain considerable length. They intersect chiefly at angles of 60° or 120°, and are so abundant that sections of the mica of the usual order of thickness of rock slides are opaque. For this reason it was often found impracticable to prepare sections by the usual process of grinding, apart from the fact that abrasion tends to destroy the symmetry of the web-like inclusions. Accordingly, most of the sections examined were prepared from the thinnest possible flakes that could be obtained by cleaving the mineral in a direction parallel to the basal plane.

Under low power magnification the needles appear dark and opaque, but this is chiefly due to the high refractive index of the rutile, for under the high power they are seen to be clear and almost colourless, and show straight extinction with crossed nicols.

A large number of sections of the mica were examined, and in each case the perfect sagenite web was found to be developed to the same extent. In no instance does the web of inclusions become sufficiently coarse to be visible to the naked eye; in fact, its consistent uniformity is a characteristic feature. The only exception is that occasionally minute six-rayed clusters of rutile, resembling pressure or percussion figures, are to be seen in some of the microscope sections; these, however, are absent in the majority of the material.

The optical properties of the mica itself are difficult to determine on account of the persistence of the web. In colour it varies from light brown to a faint smoky-grey, according to the thickness of the section. Sections parallel to the basal plane are isotropic, but no interference figure can be obtained in convergent polarised light owing to the disturbing effect of the inclusions; accordingly the axial angle could not be obtained. The refractive index is very close to that of the balsam.

Sections of the mica cut at right angles to the basal plane show the intense absorption characteristic of most biotites. It is also noteworthy that the inclusion web is not visible in such sections, so that evidently it is confined to the plane of the basal cleavage.

It was found impossible to obtain either pressure or percussion figures on the mica, probably owing to the presence of the web. Transmitted light does not produce asterism so far as can be seen from the microscope slides.

It is peculiar that the mica shows no evidence of the pleochroic haloes commonly developed in biotites since the radioactivity in the adjacent monazite would seem to provide the necessary conditions for these interesting structures.

Chemical Analysis of the Mica.

A chemical analysis of the mica was carried out primarily to determine whether it was a biotite or a phlogopite, as the general appearance rather suggested the latter mineral; the analysis, however, revealed a biotite.

Considerable difficulty was experienced in accurately determining the amount of included rutile as distinct from any combined titanium. This difficulty arose on account of the extremely fine state of division of the included rutile, as there was a marked tendency for this rutile to be partly dissolved by the weak mixture of sulphuric and hydrofluoric acids used in decomposing the mineral. The difficulty was eventually overcome by using only sufficient sulphuric acid to ensure

that no titanium was volatilised as fluoride, and relying mainly on the hydrofluoric acid to decompose the mineral, and leave the included rutile unaffected.

The estimations of titanium were done by the colourimetric method, and in the case of the determination of the total titanium the result was checked by the gravimetric method after precipitation by the basic acetate method. Since the results obtained represented the composition of the mica together with the included rutile, it was necessary to recalculate the analysis, making allowance for the amount of inclusions, in order to arrive at the composition of the mica itself.

Statement of Analysis.

	A.	B.
Silica, SiO	37·10	39·69
Alumina, Al_2O_3	13·60	14·55
Ferric Oxide, Fe_2O_3	4·47	4·78
Ferrous Oxide, FeO	7·63	8·16
Titanium Dioxide, TiO_2 ..	7·00†	·27‡
Magnesium Oxide, MgO ..	16·60	17·76
Calcium Oxide, CaO	1·00	1·07
Soda, Na_2O	1·78	1·91
Potash, K_2O	8·91	9·53
Hygroscopic Water	·40	·43
Constitutional Water, etc. ..	2·77	2·96
Total	101·26	101·11

Column A gives results for the mica together with rutile inclusions.
Column B gives recalculated results for the mica itself after eliminating rutile inclusions.
†Total titanium, *i.e.*, 6·75% included rutile and ·25% of constitutional titanium.
‡This figure for constitutional titanium is probably slightly low.
The multiplying factor for recalculating the analysis to rutile-free mica is 1·07 (approx.).

Note on Sagenitic Biotites.

The sporadic occurrence of sagenite webs in biotite and phlogopite micas is, of course, a well-established fact, and according to Iddings it is often a preliminary stage in the decomposition of a titaniferous mica.

In the case of the Normanville biotite, however, there can be no doubt that the structure is primary, or that the sagenite web is syngenetic with the mica, for the structure is developed to the same extent in the fresh mineral as it is in the partially altered varieties.

A somewhat similar mica, from Radium Hill, near Olary, has been described by E. R. Stanley.(8) The writer examined specimens of this material under the microscope and found the sagenite web to be very poorly developed as compared with that in the Normanville mica, nor does the web show regularity and continuity to the same degree.

Other Minerals present in the Pegmatite.

In addition to the minerals already described there is a limited amount of black tourmaline developed in the pegmatite. It generally occurs in graphic intergrowth with quartz. In microscope sections the tourmaline shows no abnormal features except that the colour is somewhat light for schorl, ranging, as it does, from a very pale blue to light brown.

(8) Trans. Roy. Soc. S. Austr., vol. xl., p. 268.

Pyrite was observed in one instance only, forming small euhedral crystals partly embedded in a decomposed micaceous matrix.

MAGMATIC RELATIONS OF THE PEGMATITE.

Several of the sedimentary and igneous rocks which occur in the vicinity of the "Little Gorge" have been petrologically examined by W. N. Benson,[4] who has pointed out their close mineralogical resemblance to the rocks of the Houghton magma, which are characterised by their high titanium content and, to a less degree, by the abundance of soda.

There can be little doubt that the pegmatite formation described in this paper is also genetically related to the Houghton magma. Typical exposures of this rock occur on the sea cliffs about one and a half miles north-east of the "Little Gorge," and are there associated with other varieties of pegmatite consisting of massive felspar containing coarse segregations of muscovite, ilmenite, black tourmaline, and quartz. Pegmatite of this nature can be seen to merge into the normal Houghton "diorite," from which it is evidently derived.

Less frequently, in the vicinity of the "Little Gorge," there is a development of a variety of pegmatite closely allied to Benson's "yatalite,"[5] and consisting essentially of secondary epidote and actinolite, probably after diopside, together with idiomorphic sphene and a little ilmenite.

About three-quarters of a mile south-west of the "Little Gorge," on the coast, there is an interesting quartz-ilmenite pegmatite developed in the sea cliff. The segregations of ilmenite, many of which are as large as a man's head, are plentifully distributed over the beach in the vicinity.

The great variety of rock types derived from the Houghton magma has been commented on by Benson,[6] but there are several features in connection with the pegmatite described in this paper that are worthy of special notice. In the first place, there is practically no ilmenite developed, but the high titanium content is maintained by the presence of abundant magmatic rutile.

Secondly, there is no development of diopside, actinolite, or other minerals of the pyroxene or amphibole groups, the ferro-magnesium component being represented solely by the sagenitic biotite

Finally, there is a rich, though apparently limited, development of rare earths in the form of monazite, an accessory mineral which has hitherto been unrecorded from the various pegmatites genetically connected with the Houghton magma.

ACKNOWLEDGMENT.

The analytical work in connection with this paper was carried out in the Geological Laboratory of the Adelaide University, and the writer is much indebted to Prof. Sir Douglas Mawson, not only for facilities granted, but also for the interest which he has shown in the work, and for many helpful suggestions. The writer also wishes to thank Dr. W. T. Cooke for his assistance in solving several problems in connection with the chemical analyses.

(4) Trans. Roy. Soc. S. Austr., vol. xxxiii., p. 101.

(5) *Loc. cit.*, pp. 104, 125.

(6) *Loc. cit.*, p. 137.

DESCRIPTION OF PLATES XXIII. AND XXIV.

PLATE XXIII.

Fig. 1.

General view of the pegmatite formation looking south from the Little Gorge. The foreground is an alluvial talus platform about 20 feet above sea level and is intersected by the Gorge Creek.

Fig. 2.

Polished face of monazite photographed by its own radiations, illustrating the irregular distribution of the radioactivity. Natural size. Exposure 14 days.

PLATE XXIV.

Fig. 1.

Photo-micrograph of the massive monazite showing quartz veins traversing the mineral. The dark patches represent the amorphous alteration products forming along cracks. ×35.

Fig. 2.

Photo-micrograph of the sagenitic biotite mica in section parallel to the basal plane. Showing symmetrical arrangement of included rutile needles, in thinnest possible cleavage flake. ×35.

THE RELATION OF CLIMATE TO THE SPREAD OF PRICKLY PEAR.

By Professor T. Harvey Johnston, University, Adelaide.

[Read October 9, 1924.]

Plate XXV.

In an address on the Australian prickly pear problem (Johnston, 1923) it was pointed out that the infested pear region commenced at about 22° S. and extended to 33° S., the greatest mass lying between 23° or 24° S. and 31° S.—roughly, between the latitudes of Rockhampton and Newcastle—with its greatest width between 26° and 27° S. The densest infestation lay chiefly between 25° and 30° S. and 149° to 151° E. (150° W. in the article is a misprint for 151° E.), though in southern Queensland very heavy infestation occurred between 151° and 152° E. It was indicated that the invaded area was largely included between the 20 and 30 inch isohyets, though considerable extensions occurred into the region between the 30 and 40 inch and between the 15 and 20 inch isohyets, active invasion proceeding especially between the latter two It was also pointed out that the pear region had a marked summer rainfall with an annual average of from 20 to 35 inches.

The present paper is largely an amplification of that statement, together with an examination of data available regarding other prickly pear regions of the world.

In the article referred to, the invaded area in Eastern Australia was set down as being in the neighbourhood of 40 to 45 million acres, about five million being in New South Wales. Since that was written, a Royal Commission was appointed in 1923 to inquire into the administration of prickly pear land in Queensland, its report, based on official records, setting down the area in that State as 24,179,707 acres (including 10,419,655 acres of dense pear), this diminished figure being due probably to a more careful assessment of the actual infestation of the invaded area, though the rate of annual increase (837,328 acres) was shown to be practically the same as that which I mentioned, *viz.*, 1,000,000 acres per year. The total area in eastern Australia is, then, at least 30,000,000 acres.

In view of this alarming extension now in progress, one naturally asks in which direction and how far is this invasion likely to proceed. The present paper is an attempt to answer the query by a comparative study of the chief prickly pear regions from the point of view of control by climate, chiefly rainfall. Though other factors, such as altitude, occurrence of frost, range of temperature, nature of soil, and especially the amount of evaporation which takes place, must play an important part, some of them have received only passing attention in the present paper.

Remarks on the Prickly Pears Naturalised in Australia.

As has already been pointed out by Maiden, Johnston, and Tryon, there are many species of prickly pear, nearly all belonging to the genus *Opuntia*, already naturalised in Australia, by far the most important being *O. inermis*, the next in importance being the "spiny pest pear."

The Pest Pear.—The correct name of the common pest pear of eastern Australia is still in doubt. It is generally spoken of in the Commonwealth as *O. inermis*, De C., though Maiden, in 1898 used the name *O. stricta* in preference,

but later adopted with some reserve the former name. Britton and Rose, in their Monograph (1916), regard it as *O. stricta*, Haw.

It was first described and figured by De Candolle, in 1799, as *Cactus opuntia inermis*, and referred to again by him, in 1828, as *O. inermis*. Unless it be decided that the original name is a multinominal, and therefore invalid, De Candolle's name must be regarded as having priority over *stricta* or any other name subsequently given to the species to which our Australian pest belongs. Haworth, in 1803, gave the name *Cactus strictus*, changing it to *O. stricta* in 1812, quoting De Candolle's name and illustrations at the same time. Maiden (1912, pp. 714, 716) stated that it was either a form of De Candolle's species (*O. inermis*, De C., var.), or perhaps a new species closely allied to it. He contrasted specimens from the Sydney Botanic Garden with De Candolle's figure and with *O. airampo*, Phil., mentioning that there seemed to be two forms in Australia—the common pest pear, such as occurs at Scone, New South Wales, and a more erect *airampo* form in the neighbourhood of Rockhampton; but in a later article (1913) he determined the latter as *O. dillenii*. It seems to me that De Candolle's figure agrees sufficiently with the Australian pest pear to allow one to identify the latter as *O. inermis*, consideration being given to probable slight differences in growth as a result of different climatic conditions in France and Australia.

It was suggested in 1914 (Johnston and Tryon, 1914, pp. 62, 112) that *O. bentonii*, Griffiths (1912), was either a synonym of, or was very closely related to, *O. inermis*, while Small (1919, p. 33) placed it as a possible synonym, and Britton and Rose (1919, p. 161) definitely listed it as such, though they retained Haworth's name *O. stricta* for the species. Dr. Britton informed us our pest pear was to be met with on Florida Keys (J. and T., 1914, p. 62, fig. 25), but he subsequently concluded that the species occurring commonly there was distinct, describing it as *O. keyensis* (Britton, in Small, 1919, p. 31, pl. 225; Britton and Rose, 1919, p. 222, fig. 297). During my last visit to Miami, southern Florida (September, 1920), I examined plants of *O. bentonii* and *O. keyensis*, and came to the conclusion that our *O. inermis* did not quite agree with either, though individual specimens of the first-named (originally from Apalachicola, northern Florida) were much more like the Australian plant than the others were. I think it likely that the differences from *O. inermis* exhibited by Dr. Griffiths' plant are not specific but are due to environment. *O. keyensis* is evidently closely related but distinct. The coloured figure of a flowering segment of *O. stricta*, published by Britton and Rose (1919, p. 27, fig. 4), is not quite like that usually seen in Australia, as a comparison with the coloured figure published by Maiden (1912) and with the photograph published by Johnston and Tryon (1914, fig. 3) will show, but the conditions under which the respective plants were grown would no doubt account for the difference. The latter authors have also published photographs showing the habit of the plant (figs. 1-4).

The distribution of the species in America is given as western Cuba; Florida to eastern Texas. It has been suggested (Small, 1919, p. 34) that it is probably a native of Cuba, and has been introduced into United States, America. Even in western Cuba, in the locality quoted by Britton and Rose, the few plants met with there by us in 1913 suggested that they were probably garden escapees (1) (J. and T., 1914, p. 99). Tussac quoted Hayti as the home of the species, and this may well be correct; unfortunately, circumstances prevented us from entering that Republic, though a portion of San Domingo was examined. *O. inermis* occupies almost the whole of the Australian prickly pear region excepting in one part of Queensland.

(1) A description of the species based on plants growing in the vicinity of Pinar del Rio, Western Cuba, was also published (J. and T., p. 100).

THE SPINY PEST PEAR.—This species, which has not been satisfactorily identified, occupies a considerable portion of Queensland, *viz.*, between Rockhampton and Gogango and southward to the valley of the Burnett and Mary Rivers. In this region *O. inermis* occurs sparingly and is sometimes spoken of as the "cabbage pear" on account of its colouration, which is distinct from the spiny pest pear. For a long time the latter was not recognised as a distinct form, though Maiden (1912) noticed certain differences in habit between the cactus growing in the Rockhampton district and that growing at Scone, New South Wales. We pointed out to Mr. Maiden, late in 1912, a number of differences between the two, and in 1913 he identified it as *O. dillenii*, a determination with which we disagreed (J. and T., 1914, pp. 7, 112). Britton and Rose (1919, p. 163) erroneously reported *O. dillenii* as a pest pear in Australia, evidently accepting the correctness of Maiden's determination regarding the spiny pest pear, but *O. dillenii*, fortunately for us, is a very uncommon plant in Australia.

I have used the names Spiny Pest Pear, Burnett Pear, Gayndah Pear (1922), and, lately, *O. stricta* (*O. airampo* [2]), Haworth's name being given because a specimen under that name given me whilst at Kew Botanic Gardens, when grown in Brisbane beside segments of the spiny species from the Burnett River, produced specifically identical plants. The spininess disappeared and the areoles became less pronounced in all new growth on the Burnett specimens, due to the effect of the greater moisture of the Brisbane district, so that the typical growth of *O. stricta* as known at Kew took place. It is quite probable that Haworth confused two quite distinct species, both of them with segments comparatively or practically free from prominent spines (apart from the glochidia) when grown in gardens or in greenhouses. The term "stricta" would apply much better to the Burnett pear than to *inermis*, but as Haworth admittedly renamed De Candolle's species, his name cannot apply to any other.

I have not been able to identify it from the monographs of Schumann and of Britton and Rose. The same species has run wild in many parts of the Punjab, especially between the Jhelum and Sûtlej Rivers. It was shortly described by Parker, in 1912, who thought it was *O. ficus-indica;* but I was struck with its resemblance to the spiny pest pear of the Rockhampton district of Queensland and identified this "Punjab pear" as *O. stricta* or a closely related species (J. and T., 1914, p. 10, fig. 65).

It appears, then, that this very important Australian pest pear requires to be properly identified. It is with a reluctance of several years' standing that I have decided to name it as a new species, but would suggest as a tribute to the fine work of Mr. J. H. Maiden, who has devoted so much attention to the Australian prickly pears, that the name *Opuntia Maideni* be given to the spiny pest pear of east-central Queensland—synonyms, *O stricta,* Johnston, 1923, nec Britton and Rose, 1919; *O. dillenii*, Maiden, 1913, in part, p. 1075, figs. 2, 3.

The general appearance of the plant, its flowers and fruits, are indicated in photographs already published by us (J. and T., 1914, figs. 5, 6, 7), and which readily indicate the differences from *O. inermis* in size and form of the segments and fruit, as well as in the number and size of the groups of rather long spines borne by each areole. It may belong to the group Dillenianae, and in Britton and Rose's Key (p. 159) would, if grown under natural conditions without superabundance of moisture, perhaps come next to *O. dillenii* on account of the presence of a variable, though small, number of long acicular spines. It is, however, in my opinion, more closely related to members of the section Tunae, especially

(2) After having inspected Phillippi's original plant of *O. airampo* growing at Santiago, Chile, I was led to conclude that it was different from either of the common Australian pest pears (J. and T., 1914, p. 47, footnote).

to the species *O. antillana* and *O. triacantha*, as diagnosed by those authors. The form and arrangement of the segments and spines are very suggestive of *O. antillana* as described and figured by them (1919, p. 115, fig. 144). The latter species is widely distributed in the West Indies, especially on the smaller northern islands.

The new species, *O. Maideni*, may be briefly diagnosed as follows:—Growing in dense clumps, from 3 to 6 or more feet in diameter, almost erect habit, often with short rounded or somewhat flattened stem; height varying according to amount of shade, usually 3 or 4 feet, but reaching 6 or 8 feet in some situations; segments dull greyish or yellowish-green, fairly uniform in size, usually about 150 mm. (140-200) long by 65 to 75 mm. broad, considerably narrowed at the base; segments readily detached; leaves elongate conical, 2 mm. to 3 mm. long; areoles prominent, 30 mm. to 42 mm. apart on mature segments, practically spineless and not so prominent when grown under moist conditions, but bearing a variable number of unequal spines (1 to 5, generally three or four) 20 mm. to 50 mm. in length, straight, rather acicular, yellowish to greyish; glochidi numerous; small, yellowish flowers with broad obtuse yellow petals, but sometimes a dull smoky-yellow deepening to a dull orange or brownish-yellow toward the base of the petals, and there may be a pinkish tinge at the central part of the outside of the petals; flower bud about 45 mm. to 50 mm. long; fruit reddish-purple to purple, with cavity of calyx practically obliterated when ripe, so that the mature fruit becomes almost rounded except at the extremities, one end being nearly flat and the stalk portion narrowed, total length 40 mm. to 50 mm. (1·7 to 2 inches), diameter 38 mm. to 42 mm. (1·5 to 1·7 inches). Figured by Johnston and Tryon (1914, figs. 5, 6, 7). It flowers in Queensland in late October and November. Its original habitat is probably the Carribean coast.

O. vulgaris, Mill. (*O. monacantha*, Haw.).—This species is very widely distributed in Australia, but is usually now met with sparingly. Previously it occurred as a pest pear in parts of northern Queensland, but has been completely controlled by one of the wild cochineal insects, *Dactylopius indicus*, Green, introduced from India and Ceylon by Johnston and Tryon. It occurs in more or less coastal localities in other States, *e.g.*, Sydney, Melbourne, Perth, Adelaide, and in various places southward towards Port Elliot and Yankalilla. Maiden (1908, pp. 270, 271) has referred to its presence between Port Lincoln, North Shields, and Dutton Bay. Except in the coastal belt in Queensland it has not shown any tendency to spread. Its original home is the warm, moist region of Paraguay, Uruguay, and the adjacent part of Argentina and the Brazilian coast.

O. megacantha, S. D.—A large-jointed, white-spined Mexican species, occurs commonly in the district between Rockhampton and Westwood (Central Queensland), but is restricted to it. At Scone, New South Wales, there is a large clump forming a hedge, but there has not been any invasion of the surrounding district. The species is common and much cultivated in Central Mexico. I have seen it growing commonly as a naturalised alien in a part of Oahu (Hawaiian Islands). Its method of growth and the character of the segments are such that the plant is not likely to be readily disseminated except by birds or deliberately by man.

O. aurantiaca, Gillies, is a much more serious potential pest pear which has gained a strong footing in some localities in the southern Darling Downs, as well as in scattered portions of New South Wales. Its long barbed spines and extremely brittle segments allow of its ready transportation by animals and by water, while its inconspicuous appearance may permit it to become fairly common in a locality without being obvious like the other kinds of prickly pear naturalised in the Commonwealth. Its home is in Uurguay and part of Argentina, and it became naturalised in several localities in southern Cape Colony.

Among the less important species now growing wild in Australia are to be mentioned *O. dillenii*, Haw., occurring as isolated plants in a few southern Queensland localities,[3] its home being the coasts of South Carolina, Florida, eastern Mexico, West Indies, and north of South America; *O. robusta*, Wendl., a central Mexican species with large grey orbicular spiny segments, occurring evidently as a garden escape in a few localities in the foothills of Adelaide (Burnside and Glen Osmond), and not previously recorded as growing wild in Australia; *O. microdasys*, Lehm., a low-growing central Mexican species rather common in parts of the Pilliga district, New South Wales; *O. elatior*, Mill., from northern South America (Panama to Venezuela), occurring at Liverpool, Windsor, and Gungal (Upper Goulburn-Hunter valley) in New South Wales, and very sparingly in a few localities in southern Queensland; *O. tomentosa*, S. D., a southern Mexican "tree pear" prevalent in certain localities in southern and central Queensland, but whose habit is such that the species is not likely to become a very serious pest in Australia; *O. (Cylindropuntia) imbricata*, Haw., from the highlands of Mexico and adjacent parts of the United States, America, is known to occur in a few scattered localities in New South Wales and one in Queensland; members of the *ficus-indica* and *streptacantha* group occur sparingly as garden escapes; *Nopalea dejecta*, S D., and *N. cochenillifer*, Lınn., are met with occasionally in parts of central Queensland, but are of very little importance.

Of the species just referred to, two are very important as probable pest pears if given an opportunity in Australia, *viz.*, *O. dillenii* and *O. elatior*. The former is already a widely distributed plant in maritime situations around the Mediterranean, Canary Islands, and Java, and especially in northern Ceylon and in India, where it constitutes a pest. In the latter country it is extremely widespread, occurring commonly in the Punjab, United Provinces, Rajputana, central India, Mysore, the drier portions of the Presidencies of Bombay and Madras, and is the common cactus of southern India Its extreme hardiness and its adaptability to withstand maritime conditions are referred to by Small (1919, p. 33) and Burkill (1911). *O. elatior* is also a widely distributed plant in India, occurring especially in the drier central regions from the Punjab and United Provinces to the Deccan, northern Madras, and western part of the Bombay Presidency and extending eastward to the coast in certain localities, *e.g.*, Orissa and northern Madras.

Prickly pears related to *O. megacantha* and the *streptacantha* group, referred to above, now occur widely in the Mediterranean region of Europe, Asia, and Africa, but they have been widely disseminated by man on account of the edible fruit which these species (*O. amyclea* and *O. ficus-indica*) produce, so that they are to be regarded as more or less cultivated, though they commonly grow wild, too. In South Africa the prickly pear menace is caused by a closely related species, the "doornblad" of the Dutch farmer, which has never been satisfactorily identified, though it, like the two just mentioned, belongs to the *streptacantha* group of species, the home of which is on the central Mexican tableland.

CLIMATIC CONDITIONS IN THE AUSTRALIAN PRICKLY PEAR REGIONS.

Rainfall.—In the accompanying table there is set out the recorded average annual and monthly rainfall (Hunt, 1914, 1916) of a number of places representative of (1) the invaded area in New South Wales; (2) the adjacent

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(3) Maiden recorded it from Dutton Day (Port Lincoln), South Australia, but as he had previously reported *O. monacantha*, from the same district (1908), and did not mention it when dealing with that species later (1913), it is suggested that the name *O. dillenii*, in connection with the South Australian locality, may have been a *lapsus calami*. *O. dillenii*, from Victorian localities (Mueller), is regarded by Maiden, Ewart, and Tovey as referring to *O. monacantha*.

uninvaded region to the east, south and west of (1); (3) the infested region in Queensland; and (4) the adjacent uninvaded area to the north and west of (3).

Murrurundi is close to the northern extremity of the Hunter prickly pear area; Denman (23·12 inches average annual rainfall) marks part of its southern boundary; while its eastern limit lies between Singleton (29·48) and Maitland (34·10). Moree (23·46), on the edge of the open plains; Mungindi (20·47) and Boggabilla (24·01) on the N.S. Wales-Queensland border; Warialda (28·26) and Collarenebri (18·90) are localities in the northern area in New South Wales.

RECORDED AVERAGE ANNUAL AND MONTHLY RAINFALL (IN POINTS).

	Annual Average Rainfall	January	February	March.	April	May.	June	July	August.	September	October.	November	December
1. Scone	2367	255	266	225	155	164	170	163	191	172	177	182	247
Murrurundi	3138	297	293	265	217	221	307	232	261	237	251	257	300
Moree	2346	287	302	284	137	157	188	128	139	148	190	194	192
Mungindi	2047	262	285	265	137	134	169	101	115	117	141	136	185
Warialda	2826	358	331	316	164	188	221	158	184	196	224	223	263
Tamworth	2765	263	274	238	198	193	229	174	196	222	234	269	275
Narrabri	2588	294	296	278	169	207	225	170	170	167	183	219	210
Gilgandra	2435	252	215	222	225	190	207	183	201	152	176	179	233
2. Inverell	3031	373	296	321	191	205	226	190	194	212	264	252	307
Armidale	3194	367	349	296	200	171	269	201	189	218	273	325	336
Maitland	3410	340	348	407	280	265	255	291	232	255	222	232	283
Sydney	4850	364	444	506	547	515	511	478	315	286	319	284	277
Mudgee	2531	216	237	189	180	200	252	182	194	223	224	186	247
Dubbo	2226	209	186	187	182	189	186	160	180	185	166	188	208
Trangie	1713	150	111	200	178	103	131	159	168	132	132	121	128
Nyngan	1721	204	212	179	149	136	124	109	146	096	091	118	157
Coonamble	1976	205	228	199	161	157	149	117	149	140	158	151	162
Brewarrina	1590	218	174	173	119	105	160	091	099	125	106	121	099
3. Clermont	2757	505	458	357	178	151	172	108	069	103	135	191	330
Nebo	3196	667	511	500	208	143	177	132	073	120	088	205	372
Rockhampton	4009	789	813	520	234	179	239	170	084	140	173	232	436
Westwood	3071	532	493	316	187	160	221	140	111	133	171	226	381
Banana	2807	425	366	326	129	151	185	144	107	151	219	247	357
Gayndah	3061	466	429	333	131	165	184	155	131	153	246	284	384
Toowoomba	3570	517	463	422	249	232	229	207	191	226	272	328	414
Warwick	2878	369	337	283	173	158	178	180	165	193	246	254	342
Inglewood	2787	365	313	301	135	202	199	185	142	185	229	252	279
Goondiwindi	2557	323	282	308	170	176	177	181	137	166	195	195	247
St. George	2151	314	269	250	159	160	155	131	107	120	152	155	179
Blackall	2163	314	359	270	160	190	120	111	057	074	140	133	235
Charleville	2019	235	295	277	159	160	128	119	073	068	138	155	212
Roma	2485	357	316	313	129	162	166	151	100	161	184	212	234
Yuleba	2711	406	336	346	132	167	189	180	118	140	192	270	235
Brisbane	4685	663	660	616	368	298	265	233	231	206	275	362	508
Dirranbandi	1942	275	229	249	142	131	147	101	094	123	142	121	188
Bollon	1853	246	210	231	129	115	139	102	101	103	148	143	186
4. Ravenswood	2869	755	519	479	141	095	133	049	046	091	111	163	287
Charters Towers	2552	572	427	379	173	083	150	058	041	090	076	166	337
Hughenden	1966	482	349	246	136	060	093	045	032	043	077	128	275
Winton	1528	312	290	221	078	061	076	065	027	048	050	123	177
Longreach	1716	198	411	261	084	126	090	082	025	056	108	102	173
Isisford	1920	294	320	291	170	137	120	081	068	064	084	115	176
Alpha	2330	409	386	298	176	129	178	100	072	077	134	157	214

Pilliga (20·46) and Narrabri (25·88) are in the zone to the south of it, Tamworth (27·65) lying near its eastern extremity. The south-western part of the infested region contains Collie (18·25), Gulargambone (24·28), and Gilgandra (24·35), with a slight summer maximum, and adjacent to its southern extremity is Dubbo (22·26), the rainfall of which is remarkably evenly distributed throughout the year, only a very slight increase being received during December and January.

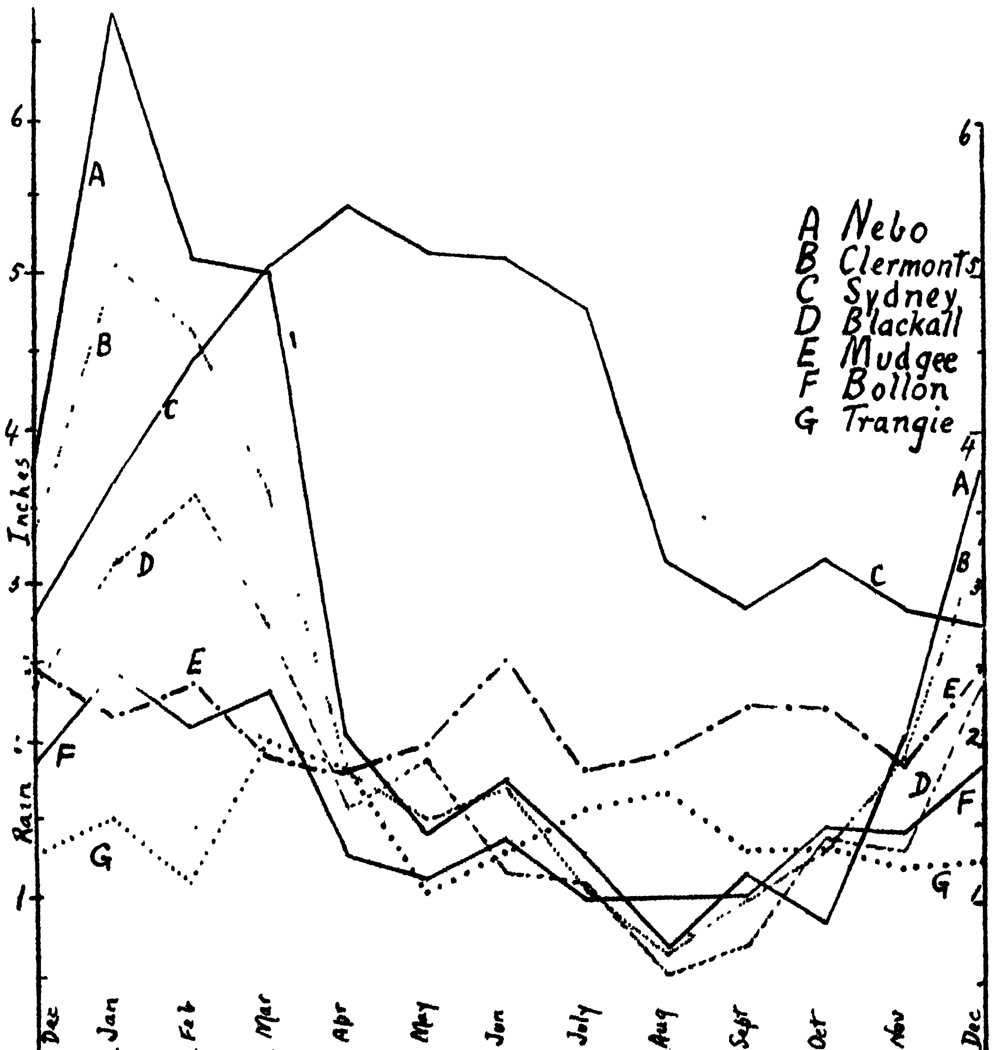
The rainfall of the regions surrounding the present pear zone in New South Wales may be indicated by that of the following towns:—Inverell (30·31) and Armidale (31·94), on the east, the latter being representative of the New England tableland; Mudgee (25·31) and Trangie (17·13), to the south of the area; Warren (18·03), Coonamble (19·76), and Walgett (18·78), just beyond its present western edge; and Nyngan (17·1) and Brewarrina (15·90), further westward. The coastal district, south of the Hunter River, receives its maximum rainfall in the autumn, March to July (*e.g.*, Sydney). It will be noticed that Armidale and Mudgee receive a well-distributed rainfall with a slight summer maximum in the former case, and a definite winter maximum in the latter. Trangie has a slight winter maximum; Coonamble a slight summer one.

On account of the more extensive invasion of territory in Queensland, a greater number of localities have been chosen to indicate the rainfall of that region. Clermont (27·57), Westwood (30·71), and Gracemere (30·78), the last-named being near Rockhampton (40·09), may be taken as representing conditions in the northern part of it, though the most northerly points (apart from coastal regions where *O. monacantha* has occurred) which prickly pear has reached (1923) are Nebo (31·54), about 50 miles south-west of Mackay, and the neighbourhood of Avon Downs (24·51), on the Sutton River, about 100 miles west of Nebo; Banana (28·07), Gayndah (30·61), and Toowoomba (35·70), its eastern edge, though there is an incursion into the Brisbane valley (Helidon, 29·41; southwardly from Laidley, 35·68, and Ipswich, 35·71; Brisbane,(4) 46·85). Warwick (28·78) marks approximately its southern limit in the direction of the New England tableland. Inglewood (27·87), Texas (27·14), Goondiwindi (25·57), and Dirranbandi (19·42) more or less mark its southern limits in the northern State, but the region between Texas and Mungindi (20·47) is continuous with the invaded area in northern New South Wales Selected localities from the Queensland region are St. George (21·51), Morven (21·69), Roma (24·85), Yuleba (27·11), Dulacca (23·74), Chinchilla (27·02), Juandah (27·47), Taroom (27·69), Auburn (25·23), Hawkwood (29·22), Bauhinia Downs (28·86). Emerald (24·93) and Springsure (26·21) mark its present boundary to the north-west, except for the isolated invaded region surrounding Blackall (21·63) in central-western Queensland. The pear has now gained a foothold near Charleville (20·19) and Bollon (18·53), which mark its present westerly limit in southern Queensland. A line drawn from Mungindi on the New South Wales border to Charleville, thence to Springsure, Clermont, and Mackay, will be just westerly of almost all the prickly pear land in the northern State, if we omit the Blackall area. If we include the latter, then the 20-inch isohyet, as indicated by Taylor (fig. 127), practically coincides with this westerly boundary between Mungindi and Blackall, though there are extensions into the zone

(4) The average rainfall of the Brisbane district varies greatly, *e.g.*, that of the city is 46·85 inches; Wynnum, a seaside suburb, 40·75; Nudgee, another suburb only a few miles away and also close to Moreton Bay, has a rainfall (at Nundah) of 31·72. It is at Nudgee that the most abundant prickly pear in Brisbane district is to be found The rainfall at the Toowoomba recording station is much greater than that received in the surrounding pear country, only a few miles away, where the average annual fall does not reach 30 inches, *e.g.*, Gowrie 29·88, Westbrook 27·69.

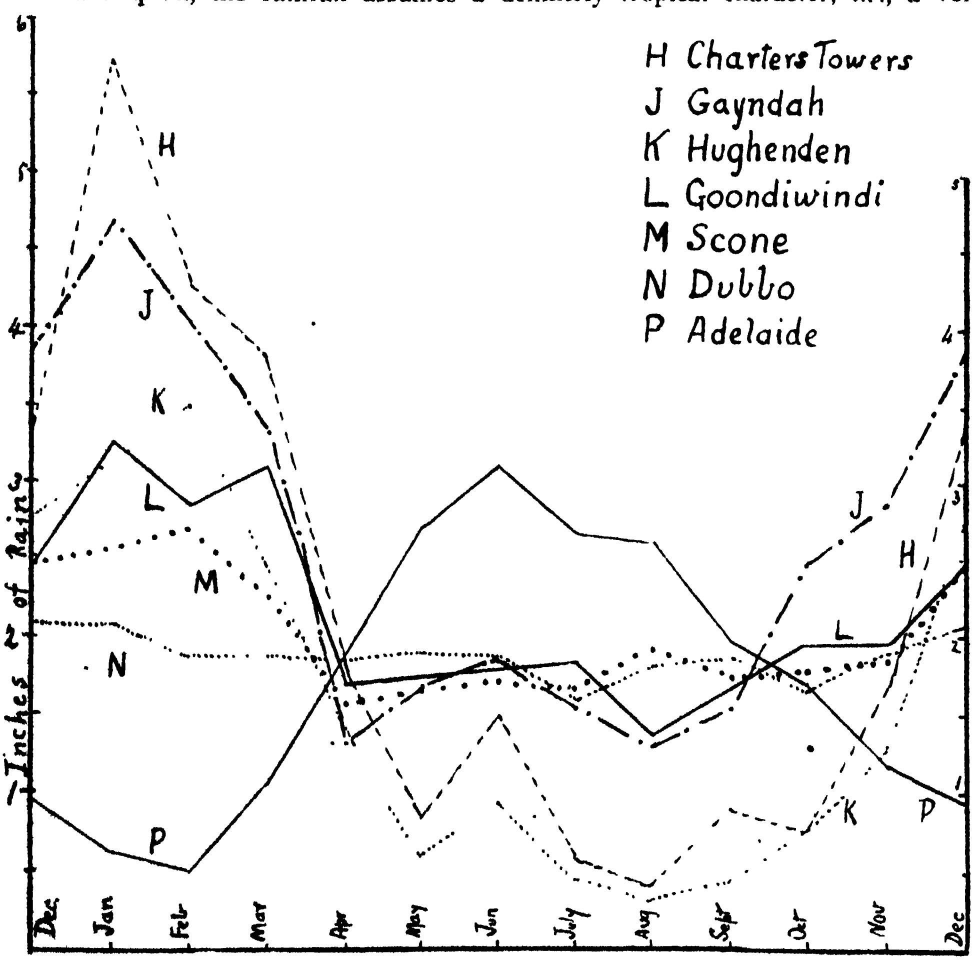
included between the 20- and 15-inch isohyets, Charleville and Blackall lying practically on the former. The mass of pear from Emerald eastward, towards Dingo (28·98), lies in a pronounced "bay" formed by the 25-inch isohyet, so that it is largely in a region having a rainfall between 20 and 25 inches.

We are now in a position to indicate the relation of the area, at present invaded, to certain climatological facts supplied by Hunt (1914, 1916) and Taylor (1918). Practically the whole of the infested region lies within the belt indicated by the latter (fig. 7) as receiving at least one inch during each of the twelve months of the year, the portion not included being the Blackall area and the country due west and to the north-west of Rockhampton, *i.e.*, the extreme northern and north-western parts of the pear region, but these lie within the zone which receives one inch for each of ten months per year



Graph showing mean monthly rainfall at Nebo (present northern limit of pear); Bollon and Blackall (western limit in Queensland); Clermont (north-western limit); Trangie and Mudgee (just beyond its south-western and southern limit); Sydney (as a type of the autumn rain occurring in the coastal region south of the prickly pear areas in New South Wales).

Practically the whole of the region, only the extreme northern part being excluded, lies in the region indicated by Taylor (fig. 127) as the "Brisbane Division" meteorologically, his northern and southern bounding lines coinciding to a remarkable degree with the boundaries of the pear area. It is a region receiving its rainfall distributed throughout the year but with a definite maximum in the summer period, from October, November, or December, to March. The southern border is marked by a line drawn between Newcastle and the north-western boundary of New South Wales. To the south of this line the rainfall inland ("Darling-Lachlan Division") is nearly uniform as to its monthly distribution, while nearer the coast ("Canberra Division") there is an autumn or winter preponderance. Still further south, as in South Australia, most of Victoria, and in south-western Australia, the fall is essentially a winter one (April or May to October), with a more or less dry summer. North of the northern boundary of the "Brisbane" climatic division, which is bounded by a line due west from Rockhampton, the rainfall assumes a definitely tropical character, *i.e.*, a very



Graph of mean monthly rainfall at Adelaide (as type of southern or winter rainfall); Dubbo (just south of the prickly pear region); Goondiwindi and Scone (fairly typical of the rainfall in the infested parts of Queensland and New South Wales; Gayndah (near the eastern limit); Charters Towers (near its probable northern limit); Hughenden (typical of that portion of western Queensland which will probably remain uninfested).

heavy summer preponderance with a more or less scanty winter component ("Townsville Division"). This is also true of the region lying to the west of the western limit of the region.

Typical graphs showing the essential features of the rainfall of the invaded territory and the surrounding areas are included in this paper. It has already been mentioned that the pear region, as a whole, has its western boundary very near the 20-inch annual isohyet, as indicated by Taylor and by Hunt (1916), while the eastern limit is almost exactly indicated by the 30-inch isohyet, prickly pear occurring outside these boundaries chiefly as scattered plants, though in some places both in Queensland and northern New South Wales active invasion of the region between the 15- and 20-inch isohyet is now taking place. Plants occur commonly in the coastal zone of the region, but do not grow in such a way as to constitute a pest. It might be remarked that these plants may be found quite close to the coast, or even beside the sea, but such situations, though receiving a high average annual rainfall (40 inches and upwards, *e.g.*, Emu Park, 43·35), may be relatively dry from the point of view of plant physiology. The 30-inch isohyet makes a detour towards the coast in the Fitzroy valley (Westwood 30·71, Stanwell 30·99), and also in the upper Burnett valley (reaching Degilbo 28·13), its limits being practically coincident with the pear infestation of those regions, while a similar state of affairs occurs in part of the Brisbane valley, the isohyet approaching within a few miles to the south of Helidon, Laidley, and Ipswich, where infestation is also present. The heaviest invasion, both in regard to density of growth and area affected, has taken place in the region between the 25- and 30-inch isohyets in Queensland, but there is a fairly even distribution between the 20- and 30-inch lines in the northern half of the infected portion of New South Wales. In the latter State the 30-inch isohyet follows the main range on its western slopes fairly closely, but makes a westerly detour to round part of the Warrumbungle Range, and then travels down the Hunter-Goulburn Valley almost to Maitland, thence south-westerly towards Orange. This incursion into the Hunter valley coincides with the limits of the Goulburn-Hunter prickly pear region, most of which lies within a similar tongue-like area bounded by the 25-inch isohyet (Scone 23·67, Muswellbrook 23·46, Denman 23·12, Merriwa 22·69, Singleton 29·54). The 30-inch isohyet in New South Wales lies just east of Texas (27·14), on the Queensland border, west of Inverell (30·60) and close to Bingara (30·49), Bundarra (29·71), and Tamworth (27·72), the first, third, and fifth-named places being located practically on the present eastern margin of the invaded region. The 20-inch isohyet in Queensland has already been referred to. In New South Wales it passes through Mungindi (20·47), thence southerly to the west of the Pilliga area, just easterly from Coonamble (19·76), Warren (17·99), Nevertire (17·92), and Narromine (18·44), but includes Trangie (20·53) and Dubbo (22·38). The relation of these districts to the invaded region has already been noted. Only a very small part of the pear zone in New South Wales lies westerly from the 20-inch isohyet.

There are a few small areas in New South Wales where pear is common and which lie outside the limits mentioned above. There is a region drained by the headwaters of the Clarence River, north of Tabulam (38·91) and Drake 40·82), recording stations in the vicinity of the area being Rivertree (32·25) and Maryland (34·43). This region, like that of the Scone district, has not appreciably extended since 1911, though the infestation may have become rather more dense. Another area is in the vicinity of Camden (30·19) and Campbelltown (27·48), south-west of Sydney. This is very restricted and has not increased to any extent. The 30-inch isohyet (Hunt, 1916) projects easterly in this locality to include a tongue of comparatively drier country surrounded by

a region having a rainfall between 30 and 40 inches. Certain species of Opuntia occur at Windsor which has an annual average of 30·75 inches.

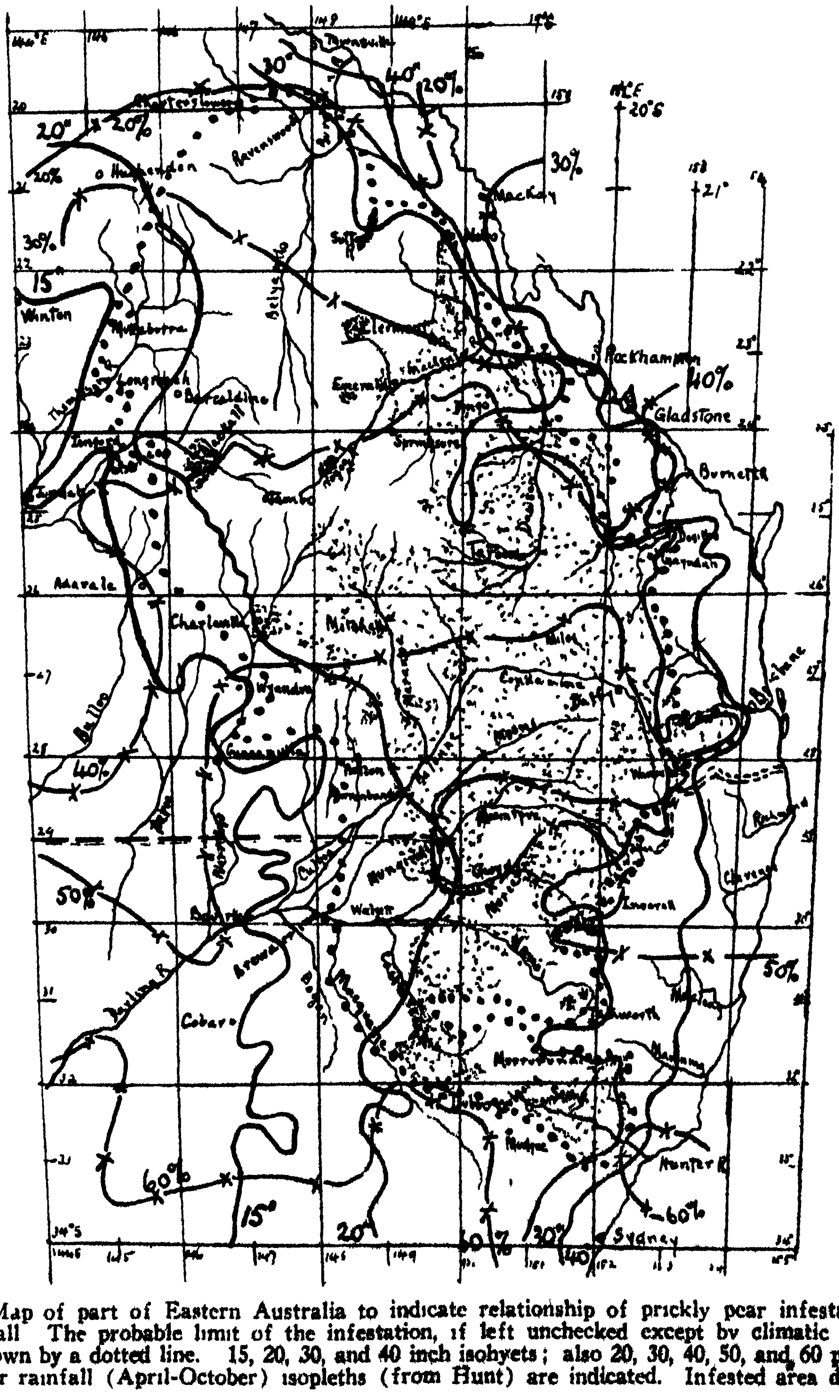
The period in which the rainfall occurs is of very great importance to plant life. Only that part is of utility which falls during the growing season of the plant (no matter what time of the year that may be), or which may be stored up in the soil and thus become available. The period from April to October, inclusive, which is the growing period for wheat, is commonly taken in Australia as a winter period; but it must be emphasised that, though cacti are dormant during the winter (from June to September, or even later) they are able to utilise both autumn and spring rains. Hence the percentage distribution of the rainfall according as it falls in the five months period, November to March (summer rain), or the seven months period, April to October (winter rain), does not express the percentage of rain available for cactus growth. Thus a 15-inch rainfall received mainly in the summer period would be of more use to such a plant than a much heavier fall received mainly in the autumn and winter months, since, in the latter case, the summer rainfall would be much lighter and the summer period itself shorter, both factors considerably limiting the growth and reproduction of prickly pear.

Hunt's maps (1914, 1916), showing the average rainfall received during the wheat-growing period (April to October, inclusive), indicate that the greater part of the region invaded by the pest lies between the isopleths for 10 and 15 inches, the latter lines corresponding very closely with the 30-inch average isohyet (Taylor, fig. 127). In New South Wales the 15-inch winter isopleth extends from the northern border near Texas, close to Bundarra (14·75) and Inverell (15·23), to the Scone-Merriwa region, thence down the Hunter valley and turning west to Wellington, where it meets the line indicating that 60 per cent. of the total annual rainfall is received during the period (April-October), Dubbo being situated to the north-west of the junction. Except for a very small area near Singleton, pear is not a pest in any part of New South Wales receiving an average of more than 15 inches during that period. It is chiefly the western third of the invaded region in Queensland which lies outside this 15-inch winter isopleth. The 10-inch winter isopleth lies just east of Warren, Walgett, Collarenebri, and Mungindi, thence more or less due north to Dingo and St. Lawrence, the Queensland portion thus lying a little east of 149° E.

The relation of the amount of winter rainfall to the total is also of interest. All the pear areas except a few northerly outliers are situated in the region where the April-October (*i.e.*, autumn, winter, and spring) rainfall constitutes not less than 30 per cent. of the total; and most of it receives, at least, 40 per cent. during that period. The 40 per cent. isopleth travels more or less easterly near Blackall, Tambo, Springsure, Dingo, Banana, Eidsvold, Rosedale, and Gladstone. The region receiving between 40 and 50 per cent of its total during the winter period includes the northern Maranoa, Taroom district, most of the Burnett area, eastern Darling Downs, and a large part of the northern pear region of New South Wales.

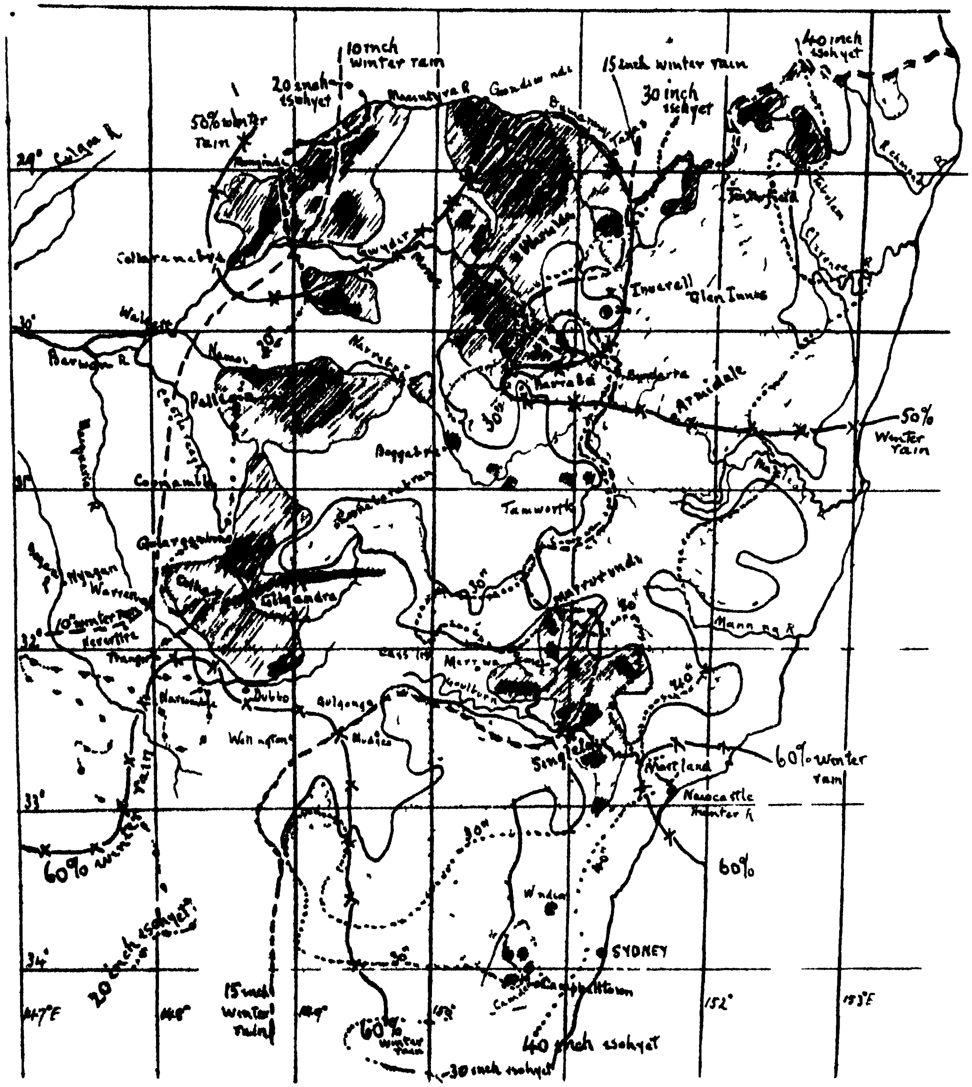
The 50 per cent. isopleth for the wheat-growing period is indicated by a line drawn from the vicinity of Bourke to Cunnamulla, and bearing east about midway between Wyandra and Mitchell, thence through Yuleba and Miles, bending northerly and then southerly to Dalby, continuing near Warwick, then turning westerly near the New South Wales border, curving across the latter west of Mungindi, thence between Walgett and Collarenebri, through Moree, north-west to Texas, southwards through Inverell and Bundara, and eastwards through Armidale to the sea. Most of the infested region in New South Wales and the south-westerly part of the pear area in Queensland receive between 50 per cent.

and 60 per cent. of their rainfall during the seven months April-October, the isopleth marking the northern boundary of the 60 per cent, winter fall taking an irregular course, passing in the vicinity of Trangie and Narromine, thence north of the latter, thence south-east to a point just south of Dubbo, thence to the



Map of part of Eastern Australia to indicate relationship of prickly pear infestation to rainfall The probable limit of the infestation, if left unchecked except by climatic control, is shown by a dotted line. 15, 20, 30, and 40 inch isohyets; also 20, 30, 40, 50, and 60 per cent. winter rainfall (April-October) isopleths (from Hunt) are indicated. Infested area dotted

north of Wellington and to the west of Mudgee, thence southwards It will be noted that this line nearly coincides with, but lies to the south of, the southern limit of the pear belt The Camden area has a winter rainfall between 15 and 20 inches constituting from 50 to 60 per cent of the total, which is similar to that experienced in the Hunter Valley



Map of portion of New South Wales showing prickly pear area (June, 1922), marked by oblique lines, the more densely infested portions being indicated by heavier marking Dotted portion represents area over 2,000 feet in elevation (sketched from map of New South Wales in "Times" Atlas, 1922) The isopleths of 50 per cent and 60 per cent winter rainfall (April October), 10 and 15 inch winter rainfall, and also 20 30 and 40 inch isohyets are indicated

The following recorded average rainfalls for the April-October period, together with the calculated percentage of the total annual fall relating to a number of towns in the pear region of New South Wales, lying between the 50 and 60 per cent. isopleths and in their vicinity, may be of interest — Boggabilla, 11·15 (46·4 per cent.); Mungindi, 9·49 (46·3); Moree 11·59 (49·4);

Warialda, 13·57 (48); Collarenebri, 9·05 (47·8); Bingara, 15·56 (51); Pilliga, 11·10 (54); Narrabri, 13·40 (51·7); Tamworth, 14·62 (52·8). Near the southern limit of the invaded zone are Scone, 11·92 (50·3); Cassilis, 12·36 (52); Gilgandra, 14·14 (57·2). To the east of it is Inverell, 15·23 (50·2). To the south of it, Dubbo, 12·76 (57·3); Gulgong, 14·79 (57·1). Adjacent to the south-west of it, Trangie, 11·44 (66·7); Warren, 9·73 (54); and to the west of it, Coonamble, 10·72 (54·4), and Walgett, 9·76 (52). Except the infested area just north of Dubbo and situated in the vicinity of Gilgandra, all the pear regions apparently receive not more than 55 per cent. of their supply of rain during the winter (April to October).

Altitude.—The prickly pear region shows some relationship to altitude which is not unexpected, since the Main Dividing Range is largely responsible for the position of the isohyets in eastern Australia. Most of the infested territory occurs on the western slopes of the range and lies at an elevation between 1,000 and 2,000 feet above sea level, extending into the western plains (500 to 1,000 feet), but not occurring on the New England plateau (from a point just south of Warwick southwards), where the elevation is over 3,000 feet, while the region between 2,000 and 3,000 feet in elevation is practically, if not quite, free from the pest. The infected portion of the valleys of the Burnett and Brisbane Rivers is less than 500 feet above seal level. The limits of these elevations are broadly indicated by Taylor (fig. 127). The more or less isolated condition of parts of the eastern portion of the area in New South Wales is seen to be very definitely related to land contours. The New England tableland, from the Queensland border to Murrurundi, has an altitude of not less than 2,000 feet, and extends quite close to the coast in many places north of the Hunter River. On the western side it has rather narrow prolongations which dissect the prickly pear region, the most pronounced being the Nandewar Range, which extends westwards between Bundarra on the north and Narrabri-Tamworth detached pear areas on the south, and a much larger mass, the Warrumbungle Range, which extends westwardly from Murrurundi beyond Coonabarabran and forming a boundary for the south-western pear region. The Hunter-Goulburn area lies in a less elevated tract bounded closely by tablelands over 2,000 feet (Mount Royal, Liverpool, and Hunter Ranges), so that it forms a comparatively narrow region communicating with the western plains beyond Merriwa and Cassilis. The only part of the pear area in New South Wales which lies at a greater elevation than 2,000 feet is a small detached district adjacent to the Queensland border, in the headwaters of the Clarence River (near Maryland), while the neighbouring infested region (just north of Tabulam) lies below that elevation.

The effect of elevation is not so marked in Queensland, probably on account of the higher temperatures compared with those in New South Wales. Besides, the total area over 2,000 feet in height is relatively small in comparison with that in the Southern State, and in great part lies a long distance inland. There is a small northward extension of the New England plateau reaching Dalveen, and in this region pear is absent. The Main Range, which is a very narrow continuation of the plateau, tends northwards and then westerly as the Bunya Mountains. Scattered or dense pear occurs at intervals along one or other or both sides of these ranges, but the northerly extension (Main Dividing Range) beyond the Upper Maranoa watershed traverses a region almost free from pear at present, there being only a few small isolated infected areas, *e.g.*, Nogoa River and Buckland Creek, a little near Springsure, and some east of Withersfield. An elevation of 2,000 feet in Queensland presents no striking line of demarcation between infested and pear-free territory. It may be pointed out that the greater part of the invaded region in that State lies at an altitude less than 1,000 feet.

Watershed.—It may be noted that, apart from the comparatively small areas situated in the Burnett, Brisbane, and Hunter valleys, nearly the whole of the invaded territory is drained by two river systems, *viz.*, the large streams Isaacs, Mackenzie, and Dawson, which form the Fitzroy, and the extensive rivers which belong to the Darling basin. Amongst the latter may be mentioned the Condamine, Dumaresq, Macintyre, Barwon, Gwydir, Namoi, Castlereagh, Balonne, Maranoa, and Mooni. The upper part of the Warrego watershed is infected, as also are some of the creeks situated between the Warrego and the Balonne. The Blackall area, however, lies in the Barcoo watershed.

Temperature.—The average January (midsummer) temperature of the various parts of the pear region as indicated in Bartholomew's Physical Atlas (Vol. iii., Meteorology) lies between 77·5° F. and 80° F. in the case of the area including Brisbane, Toowoomba, Warwick, and most of the invaded portion of southern Queensland, while that of the New South Wales section lies between 80° F. and 85° F. The average July (midwinter) temperature in the Darling Downs area and the adjacent tracts in New South Wales lies between 55° F. and 57·5° F.; in the remaining pear regions of New South Wales, 52·5 to 55° F.; in the area lying north of a line drawn through Brisbane and Dalby (Darling Downs), 57·5°F. and upwards. The average annual temperature of the Darling Downs and New South Wales areas lies between 67·5° F. and 70° F.; of the area from Brisbane and Dalby northward, 70° F. to 75° F., most of it falling between the 70° F. and 72·5° F. annual isotherms.

Frost.—The frost map of Australia (Hunt) indicates that the western and most of the northern parts of the region infested with pear are subject to frequent frosts during the months May to September; while the eastern, central, and southern portions experience such a condition from April or May to September or October, *i.e.,* for five, six, or seven months, according to the locality. In the coastal belt in southern Queensland and northern New South Wales, frost occurs from June to August, just as happens at Blackall. The northernmost portion (north of Emerald) experiences frost from May to August; and the southernmost, the Hunter valley, from April to October, a period during which most of the New South Wales pear areas and part of the region which lies in Queensland are also subjected to it.

Vegetation.—If the prickly pear area be compared with Taylor's "Vegetation Map" (fig. 10) it will be noticed that it falls in the three regions marked respectively as savannah forest, brigalow, and savannah plus brigalow. There is, practically, none in the typical savannah country, whereas the pest thrives in the open timbered region (forest or brigalow). The line indicating the eastern limit of the savannah, or the western limit of the mixture of savannah and brigalow or forest, marks out very closely the westerly boundary of the prickly pear. It seems, then, that the climatic conditions which lead to the formation of a savannah and to the absence of timber, are such as limit the growth of prickly pear. This savannah region is indicated by Taylor (1918, p. 28) as possessing a rainfall between 10 and 20 inches annual average, received during the summer in the north and the winter in the south, and as having an annual temperature of 70° F. to 90° F. in January and 45° F. to 75° F. in July. It has less rainfall and much wider extremes of temperature than the brigalow or savannah forest. The brigalow region has a rainfall of 10 to 20 inches, chiefly in summer, with an average temperature ranging from 85° F. to 88° F. in January, and 55° F. to 70° F. in July. The savannah forest contains a goodly quantity of grass in addition to the dominant tree flora, such as eucalyptus and acacias; receives its rain (15 to 50 inches) in the north chiefly in summer, but more uniformly in the east; and has an average range of temperature 75° F. to 88° F. in January,

and 45° F. to 75° F. in July. The higher rainfall and temperatures belong to the northern portion of this region which lies beyond the pear areas.

Summary.—The prickly pear region in eastern Australia may be said to occupy that portion which has an average annual temperature between 67° F. and 75° F., the mean minimum for midwinter being 52·5° F., which has an annual average rainfall between 20 and 30 inches, received especially during the five summer months, the wettest months being during summer (40 to 70 per cent. of the yearly total), but with an inch or more during most of the winter months; which lies definitely to the north of the line indicating uniform rainfall distribution throughout the year; which has an elevation less than 3,000 (mostly less than 2,000 feet); which is liable to experience frost for from five to seven months in the year; and whose natural vegetation may be classed as a "brigalow forest" or as a "savannah forest" and not as a more or less pure savannah (practically treeless grassland).

Homoclimes of Australian Pear Region.—The homoclimes of the "Brisbane Division" which includes this pear region, are stated by Taylor (1918, p. 128) to be found in East Cape Colony, Uruguay, and south-eastern United States, America, which all have a mean annual temperature of about 70° F., with a mean annual range of about 20° F. in Uruguay and 30° F. to 40° F. in the United States, America; but the Australian maximum is greater than that of the others. All have the same type of rainfall with a midsummer maximum, though the United States, America, and Uruguay receive more rain during winter. It is of interest to note that some of the species of Opuntia naturalised in Australia are native of Uruguay and south-eastern United States, America, while eastern Cape Colony has a prickly pear problem of its own. It is worthy of note that Taylor (p. 14, 156) has listed Montevideo as a homoclime of both Sydney and Brisbane regions. Except for its greater rainfall (38 inches) it would agree with the Hunter pear area. The places mentioned by Taylor resemble the southernmost part of the pear area of "Brisbane Division" rather than the remainder of it. The homoclimes of western New South Wales, which has a comparatively uniform rainfall and which borders on the south-western edge of the pear belt, include, according to Taylor (p. 140), San Antonio, in Texas, with an average rainfall of 25·2 inches and an average annual temperature of 67·8° F. (range 51° to 82·4°), and Cordoba, in eastern Argentina (25·2 inches rainfall, 62·4° F. mean annual temperature). The former is situated in southern Texas and marks, approximately, the northern limit of heavy Opuntia growth in that portion of the United States, America, while its climate (temperature and rainfall) is practically identical with that of the Narrabri, Pilliga, or Scone prickly pear regions in New South Wales, so that San Antonio is really a homoclime of the southern regions of the "Brisbane Division" rather than the adjacent north-eastern part of the Darling-Lachlan division. The data available to the writer regarding Cordoba show that it receives its maximum rain in summer, its average rainfall and its temperature being that of the southern pear region in Australia, so that Cordoba, like San Antonio, is a homoclime of Scone and Pilliga districts.

Another homoclime mentioned by Taylor is Oklahoma, with a rainfall of 28 inches and an average annual temperature of 58·6° F., ranging from 54° F. to 80° F. This is definitely outside the pear belt [5] of the United States,

[5] The terms "pear belt" or "pear region" are used in this paper to denote areas where Opuntias thrive and occur abundantly. In the New World the genus is very widely distributed, but it is in certain portions of it situated between Florida and southernmost California, as a northern boundary, and Mendoza (Argentina) to Uruguay, as its southern, that the plants reach their maximum in regard to number of species and of individuals.

America, and though the rainfall is such as would promote good growth of Opuntia, the limiting factor must be the lower average annual temperature, and especially the cold winter.

The "Canberra Division" (taking Sydney as typical) has for its homoclimes, according to Taylor, Port Elizabeth (Cape Colony), Montevideo (Uruguay), and Wilmington (N. Carolina). It is of interest to note that Sydney is definitely outside the typical prickly pear area, and this is true of the Port Elizabeth district, though a Uruguayan Opuntia occurs close to the latter, as it does in the Hunter valley. Carolina is just beyond the eastern United States, America, pear region, which ends in South Carolina or eastern Florida. This particular region and its homoclimes are of importance, as they must possess some feature or features which are not favourable for the spread of prickly pear. Sydney district is the oldest settled part of Australia and has several species of Opuntia (including the pest pear and *O. aurantiaca)* growing wild in its vicinity, and yet they have not spread, though locally more prevalent at Camden and Windsor. The factor is certainly neither that of temperature nor altitude, but is most probably that of rainfall. The latter is apparently excessive along the coastal zone for the naturalised species, but this would not explain the absence of the pest along the northern boundary of the "Canberra Division," where the amount received annually is similar to that of the adjacent pear areas in northern New South Wales. It is then, practically certain that the primary limiting factor is the amount of rainfall received during that period (summer) in which seed germination and active growth and reproduction of the plant occur. A dry summer largely prevents these from taking place. An excessive rainfall (over 35 inches —probably over 32) also seems to be detrimental to most species, though it must be emphasised that it is not the total rainfall (whether great or small) which is a true index to the plants' needs, but rather that part of it which they can utilise. Imperfect soil drainage is highly detrimental to most cacti.

The "Adelaide Division," as well as "Swanland" (south-west of Western Australia) has a single winter maximum and a single summer minimum rainfall, and possesses a climate like that of Cape Town, Valparaiso (Chile), and a great part of the Mediterranean region. The "Victorian Division" is essentially the same, except for an increased summer component in the rainfall, especially in the eastern portion. The Mediterranean is the only one of these localities in which Opuntias are abundant, but it must not be forgotten that the chief species occurring there are such as produce an edible fruit which enters largely into the human dietary in the region, so that the plant is one which is afforded every opportunity by man for its spread by seed or by vegetative propagation, and yet it has not overrun the area to the exclusion of other vegetation. The obvious reason is that the Mediterranean, like the southern part of Australia, is a region of winter rainfall, with comparatively dry summer.

We have examined the Australian prickly pear region in regard to its climatic conditions and have compared it with certain other parts of the world. We may now make a brief survey of the conditions occurring in the pear regions of the Old and New Worlds, in order to ascertain, if possible, the direction in which further extension of the pest in Australia is likely to take place, assuming that it is not controlled in some other way, e.g., by biological, chemical, mechanical, or administrative agencies. Taylor (1923, figs. 7, 8, 12) has published some diagrams comparing the Australian climatic zones with those of North America, Northern Africa, and India. The Australian pear region corresponds in latitude with Mexico, Florida, and the Gulf States of the United States, America, while the Barbary States, of northern Africa, are shown as corresponding climatically with the southern part of the Commonwealth.

Climatic Requirements of Prickly Pears.

A certain amount of work has been done on the climatic requirements of prickly pears in the United States, America. In 1896 Coulter pointed out that the majority of species of flat Opuntias then known to occur in the United States, America, were found in its south-western portion, Texas leading in regard to the number of species, with New Mexico next, Arizona third, followed by southern California. In 1905 Griffiths mentioned that the northern boundary of the cactus area in the United States, America, extended from the Texas-Louisiana line, westward, along 33° N. to the Texas-New Mexico border, thence north to 39° N., thence west, but the great Opuntia region comprised that part of Texas lying south of 30° N., since in southern California, Arizona, and New Mexico there were either comparatively few individuals, or else they were relatively small. In 1906 Griffiths and Hare stated that prickly pears throve best in a region which had a relatively equable temperature and a considerable rainfall periodically distributed; that these plants occurred naturally and in the greatest profusion on the Mexican plateau, but that the region was not hot, and, though very dry during a large part of the year, yet it had a considerable average rainfall, that of Zacatecas for ten years being 31·5 inches, distributed as follows: from January to April and from October to December only, ·62 to 2·12 inches, while the average for the remaining months was from 3·5 to 7·12 inches per month, June, July, and August (*i.e.*, summer) having 4·25 to 7·12 inches each (1906, pp. 29, 30) The information was republished in another article by these authors in 1907. Next year Griffiths, in discussing the value of prickly pear as a farm crop in southern Texas, published the monthly rainfall of San Antonio for a period of ten years, showing a marked preponderance of summer rain (April to July), but with irregular distribution during the remaining months, the average annual fall (18 years) being 28·4 inches. He pointed out that these plants were especially adapted to regions where the rainfall was considerable though irregularly or periodically distributed, and that the popular belief that they would grow with little or no water was incorrect. A high average temperature during summer was held to be an advantage for their growth (1908, pp. 8-10). In dealing with the so-called "spineless" prickly pears (1909, pp. 15-17), he indicated the region in the United States, America, where these Mexcian species might be grown (the Gulf Coast from Florida to the Rio Grande; southern Arizona to the Sacramento valley, in California), the minimum winter temperatures experienced outside these areas preventing their growth, but stated that cultivation was necessary in the Sacramento valley to conserve sufficient moisture in the soil after the spring rains had ceased. In a subsequent publication (1912), recording later observations, he very greatly reduced his estimate of the extent of territory favourable for the growth of these plants. A temperature of 20° F., if continued for any length of time, was regarded as fatal to them. He went on to state (p. 12) that ideal conditions for spineless as well as spiny prickly pears were found on the highlands of Mexico where there were two rainy seasons, one in winter, and the other, more pronounced, in summer, while over much of the region a minimum temperature of 25° F. was seldom experienced.

In 1911 Wooton, who studied the cactus flora of New Mexico, referred to the extensive shallow rooting system of these plants making possible a rapid absorption of moisture which in arid regions is received from rainfall mostly torrential in character. He also pointed out that though cacti were able to endure great daily and annual ranges of temperature, they were adapted to a region where the temperature was moderately high but not excessive, where the minimum was not very low (though a minority of the species could withstand continued and severe freezing), and where the rainfall was periodic and moderate in amount, with intervening periods of drought. New Mexico possessed climatic

conditions which were not favourable for most species, being too cold or too dry, so that cacti formed a subordinate part of the vegetation of that State, though they were obvious on account of their striking appearance. The temperature and rainfall varied greatly in different parts, low precipitation being associated with warmer temperatures and higher rainfall with colder weather, so that the necessary amount of rain and degree of temperature were not available at the same time.

Thornber (1911) published information regarding the behaviour of cacti in Arizona, where there are two periods of growth (at lower altitudes), one in spring and early summer following closely on the winter rains, and the other during the rainy season in summer, when moderate to heavy rains occur, a shortage in either winter or summer rains causing a check in cactus growth. These plants are dormant during the dry spring and summer months, and also October to February inclusive (winter), as well as during any prolonged drought, though flowering and fruiting may take place. The destructive effect of grass fires on young cacti was noted.

In the preceding year this author (1910) published considerable climatological data regarding certain localities in Arizona. In the eastern and south-western portions the summer rainfall (July to September) exceeds that of the winter and early spring (November or December to March) and is usually over one-half the total, while in the region north and west of Tucson the spring and winter rainfall is the greater. At Tucson the latter averages about an inch below that of the summer; April, May, and June are very dry months, while October and November are also dry; the annual average being 10·76. In the Pacific Coast States the rainy season occurs during the winter and spring months.

In 1913 Griffiths published the results of his observations on the behaviour of Opuntias under cultural conditions, mentioning that some inland species did not thrive when grown at Brownsville, in southernmost Texas, where the climate was too humid for them, though those from the central Mexican highlands were found to be hardy at Brownsville, as well as at Chico in northern California, where there was a heavy winter rainfall. Species of Nopalea and also Opuntias from southern Mexico did not grow in Texas (Brownsville and San Antonio) or California (Chico), unless protected against winter.

The climatological data to be presented in the succeeding part of this paper are gathered from Bartholomew's Physical Atlas, vol. 3; Kendrew (1922); Thurston (1913); Douie (1916); O'Malley (1917); and the official year books of South Africa (1922, 1923), especially the first two named. It is intended to review the climatic conditions, firstly, in the pear regions in the vicinity of the Gulf of Mexico and Caribbean Sea (since most of the pest species are natives of that habitat); then those in South America (from which a few widely acclimatised species have been derived); and lastly, those of the regions where cacti have become thoroughly acclimatised such as India, Ceylon, South Africa, and the Mediterranean littoral.

North America and West Indies.—The average annual rainfall of Florida and the Gulf Coast of the United States, America, except Texas, is between 40 and 60 inches (Key West, 38). It is well distributed in summer and winter with a slight maximum in late summer, but very little falls in autumn (October) and spring (April). The central region of North America, including most of Texas and Mexico, has its maximum in early summer (June) with little rain in winter, December and January being dry. The eastern portion of Texas, including Austin and Brownsville, receives 30 to 40 inches; central Texas, including San Antonio, 20 to 30; while western Texas, part of Arizona and New Mexico, also southern California, receive 10 to 20 inches; the remainder of Arizona and New Mexico, under 10 inches per annum. The 10- to 20-inch

isohyets include the Rio Grande region of northern Mexico. This Arizona type of rainfall is the result of two influences, the Pacific supplying a maximum in winter and an intense local heating in late summer causing showers in July and August, while June is practically rainless A table of average monthly rainfall at three centres in southern United States, America, *viz.*, Miami (Florida), San Antonio (Texas), and San Diego (southern California), published by Kendrew. shows the marked summer preponderance at the two former and an almost rainless summer in southern California (9·6 inches annual average) From 35 per cent. to 40 per cent. of the annual total is received during the summer period, July to September, on the south and east coasts of Florida; 30 to 40 per cent. in west-central Texas, Arizona, and New Mexico in July and August; and 40 per cent. in western Texas and the adjacent northern portion of Mexico (Chihuahua), chiefly from July to September. The Mexican mean annual rainfall varies from 10 to 20 inches in part of the north (Chihuahua city, 24·2) and centre extending to San Luis Potosi; 20 to 30 inches in the belt surrounding that region and including Mexico city (23·1) and most of northern Mexico; 30 to 40 inches in the more southerly portion (Zacatecas 31, Durango, and Tehuantepec).

Southern and south-western Cuba and southern Haiti (the pear regions of these islands and the home of *O. inermis)* have an annual fall of 40 to 60 inches, part of Jamaica (Kingston) 30 to 35 inches, but most of the West Indies have a higher rainfall Prickly pear is abundant, especially on the smaller islands and particularly along the coast of nearly all, but, as already pointed out, the marine littoral is typically a dry region from the point of view of plant ecology or physiology, on account of the increased salinity. The rainfall in the West Indies is essentially a summer and autumn one—June to December, especially August to December. On the Venezuelan coast and Trinidad there are two periods of heavy rainfall, *i.e.*, the equatorial type like that of central Africa.

The midwinter (January) average temperatures (in Fahrenheit) of the region are as follow:—Key West 68°, Miami 64°-68°, western Florida 55°, San Antonio 50°-53°, Brownsville 61°, Tucson 56°, San Luis Potosi 71·6°, Zacatecas 69°-71°, Chihuahua 57°; while the Gulf coasts and the region between Savannah (South Carolina) and Monterey (California), and lying well to the north of the pear zone, have an isotherm of not less than 10° C. (50° F.) during that month. The average temperature in midsummer (July) at San Luis, Potosi, Zacatecas, Brownsville, and San Antonio is 86°; Chihuahua and Tucson, 93°; Louisiana, Alabama, Carolina, Florida, and the Gulf Coast generally, 79° to 82°. The 68° F. (20° C.) isotherm of average annual temperature includes Florida, the Gulf Coast, a large part of Texas (from Austin southwards) and southern Arizona, but lies to the south of southern California.

The main prickly pear region of North America is, then, limited northwards by a mean annual isotherm of nearly 70° F., with a mean midwinter (January) isotherm of not less than 50°, and a mean midsummer (July, August) temperature of at least 80° F. The chief pear region of Mexico has an average temperature between 60° and 70° in January, and about 90° F. in July, with a mean annual average between 70° and 80°. The West Indian Islands have an almost equable temperature, the average ranging from 79° in January to 82·5° in July.

South America.—The maximum rainfall occurs in the winter along the Pacific Coast, but during summer along the eastern Andean slopes (Peru to Mendoza) and in northern Argentina (to Buenos Aires), 35° S. marking approximately the limit of summer rain maxima, and this is almost exactly the southern limit of the region where good pear growth takes place in that continent

(see Kendrew for graphs of monthly rainfall of parts of Argentina, including that of Mendoza district, which is under 10 inches).

In the dry Caatinga—a "thornveld" region rich in cacti, especially Cereoids—inland from Bahia, in north Brazil, the rainfall is scanty (10 to 20 inches) and occurs in summer and autumn, there being six almost rainless winter months and a very great variation in the annual amount.

Southern Uruguay and that part of Argentina (Bahia Blanca) which lies to the south of it, have a comparatively uniform rainfall (20 to 30 inches) with a slight winter maximum, though that of Montevideo (38·5) is practically uniform, as the following monthly averages, commencing with January, show:—3·2, 2·4, 3·5, 3·4, 3·9, 3·3, 3·3, 2·7, 3·1, 3·7, 3·0, 3·1 inches, while Buenos Aires, though only a short distance away, has a definite summer maximum (December, January, and March). The coastal region of Brazil and the adjacent districts, which constitute the native home of *Opuntia monacantha,* have a high average rainfall, 40 to 80 inches, with a definite summer maximum (*e.g.*, Rio Janeiro's monthly averages, from July onwards, are 5·0, 4·3, 5·3, 4·4, 3·5, 2·0, 1·6, 1·8, 2·6, 3·2, 4·3, 5·4; total, 43·4 inches).

The midsummer (January) average temperature is about 80° F for almost the whole of the pear region, the Andean portion and Uruguay lying between the 70° and 80° isotherms, but much nearer the latter. In July, southern Brazil and northern Argentina lie between the 60° and 70° F. isotherms, while the central region of the latter, as well as Uruguay, falls between the 50° and 60° isotherms. The main Opuntia areas of South America have an average annual temperature between 65° and 73° F., corresponding extremely closely with the range exhibited in the Australian area.

India and Ceylon.—The portions of India which have permitted good growth of *O. monacantha* are those with a heavy rainfall, *e g.*, the Gangetic plains where the species was formerly rather abundant. The regions in which either *O. elatior*, *O. dillenii*, or the "Punjab pear" is prevalent, *viz.*, portions of the Punjab (*e.g*. Lahore, 20·7; Jullundur, Delhi, 27·7; Jaipur, 25·0), United Provinces, Central India, Deccan, northern Mysore, and the eastern highlands of Bombay Presidency (Poona, 28·3) have a rainfall between 10 and 30 or even 40 inches (Thurston, Douie, Kendrew). The Madras Presidency receives 10 to 30 inches per year in its southern portion, where *O. dillenii* is very prevalent, while the remainder of it averages between 30 and 50 inches, as do also most of Mysore, Hyderabad, Deccan, and Berar. The monthly distribution of this rainfall, at a number of selected places, including the localities just mentioned, is given by Kendrew (p. 193). Bengal, Bihar, and Orissa, which are outside the region where pest prickly pears are prevalent, have a high annual rainfall, being 50 to 100, 50 and 58 inches respectively (O'Malley), while the coastal strip of the Bombay Presidency receives 120 inches per year. The Indian rain is almost entirely received in the monsoon period, between June and October, very little falling during the very hot season, March to May, and least during the relatively cold season, January and February.

Northern Ceylon has abundant pear (*O. dillenii*), and this region is the driest in the island, receiving its rain chiefly from October to December, while the other portions obtain their rainfall during either the north-east monsoon, January to March, or that of the south-east (June to September).

The isotherms for January and July, and the mean annual isotherms for northern Ceylon are, respectively, 77·5°-80°, 85°, 82·5° F.; for southern India (Madras Presidency), 75°-77·5°, 85°, 82·5°; for central India and Deccan, 77·5°-80°, 82°-85°, 80°-85°; Lahore district, 55°-57·5°, 90°-92°, 77·5°; Delhi region, 60°-62°, 87°-90°, 77·5°-80°. The midwinter mean temperature of the

pear infested areas is thus at least 55°, the midsummer mean, not less than 80°, and the mean annual between 77° and 85° F.

South Africa.—Though *O. monacantha* occurs in Natal and near Cape Town, the real prickly pear region is in eastern Cape Colony, including the Graaff Reinet, Middelburg, Cradock, Somerset, Beaufort, and Bedford districts particularly, where certain Mexican species (*streptacantha* group) have monopolised the land, while further to the south, in the Humansdorp district, near Port Elizabeth, a Uruguayan species (*O. aurantiaca*) was locally prevalent. This pear zone lies especially in a region with a low average annual rainfall (10-30 inches, chiefly 15 to 20), and in the southern part of it (*e.g.*, Bedford) receives from 60 to 70 per cent. of it during the summer (October to March), while the northern portion (northward from Graaff Reinet and Cradock) obtains 70 per cent. to 75 per cent. during that period. Humansdorp is on the line of equal summer and winter components. Port Elizabeth receives between 50 per cent. and 60 per cent. of its total in winter, between April and September; Capetown (25 to 45 inches total), over 70 per cent. during winter; while Natal receives between 60 per cent. and 85 per cent. of its 30 to 50 inch total during summer, the percentage increasing with the distance from Durban (61 per cent. to 75 per cent.; Pietermaritzburg, 75 per cent. to 85 per cent.), and, in the Transvaal, it is 85 per cent. to 90 per cent., while in the northern Transvaal 95 per cent , or more, falls in the summer The average annual rainfall of the chief infested localities and the percentage which falls during summer are now given: Alice, 22·8 (66 per cent.); Beaufort West, 9·46 (66); Cookhouse, 16·2 (71); Cradock, 15·2 (68); Fort Beaufort 21·65 (68); Graaff Reinet, 14·64 (66); Middleburg, 13·85 (72); Humansdorp, 26·88 (50); Hankey, 16·79 (53); Uitenhage, 18·25 (52). Other records of interest are Capetown (Platte Klip), 45·12 (24); Durban, 41·87 (71); Pietermaritzburg, 35·97 (82); Johannesburg, 29·03 (87); Pretoria, 29·80 (91); Bloemfontein, 22·05 (76).

The mean temperatures for January and July, as well as the average annual temperature of towns in the pear region in Cape Colony, fall between the following isopleths:—Graaff Reinet and Cradock, 82·5°-85° F., 60°-62·5°, 70°-72·5°; Bedford, 77·5°-80°, 60°-62-5°, 70°-72·5°; Humansdorp, 72·5°, 57·5°-60°, 62·5°-65°; Uitenhage, 75°, 57·5-°-60°, 62·5°-65°; [Capetown, 70°, 55°, 60°-62·5°]. The mean annual temperature of the true prickly pear zone in South Africa is thus between 62·5° and 72·5° (range, 57° to 85° F.). A Uruguayan species was rather widely distributed throughout the region, but occurred most commonly in a few localities in the southern part of it, *e.g.*, Uitenhage and Humansdorp.

This rather large invaded area is on sediments belonging to the Karoo system and lies chiefly in the vegetation zone labelled as thornveld, but a part has invaded the eastern portion of the Karoo. Humansdorp district lies in a rather small coastal forest belt. The Free State and Transvaal—"high veld"—have too high an altitude for vigorous prickly pear growth, while Natal has too great a rainfall, except for *O. monacantha* and allied species. The remainder of Cape Colony is either too dry or else receives too small an amount of summer rainfall to allow of extensive growth of Opuntias, though *O. monacantha* grows well as isolated plants or as clumps in many parts of South Africa from northern Transvaal (Pietersburg) to Capetown and Durban, but it is only in eastern Natal, with its subtropical climate, that the species has increased to such an extent as to require attention. South African experience in regard to this plant—a native of the moist tropical and subtropical parts of eastern South America—is very similar to that in Australia, since it was only in Queensland that it became a pest, though the species is to be found growing naturalised in several southern Australian

localities such as Perth, Adelaide, Melbourne, Sydney, occurring chiefly as an escape plant from gardens or hedges.

The Mediterranean Littoral.—It has already been mentioned that though Opuntias are very common in this region, the chief species, *O. ficus-indica* and *O. amyclea,* have not constituted themselves a nuisance, though they were widely distributed long ago, probably soon after the discovery of the New World. These are very much utilised by man for the sake of their edible fruit, and are perhaps to be regarded as more or less semicultivated, and either deliberately propagated or else allowed to propagate from fallen segments. If seed germination occurred to any appreciable extent, and conditions were favourable for the growth of seedlings, there would have been a very dense infestation by this time, but it has not occurred. *O. dillenii* is widely distributed around the shores, but it has not become a menace there as it has done in southern India and northern Ceylon. What are the factors which have limited growth in the Mediterranean? The outstanding fact in regard to its climate is its winter rainfall and very dry summer. The latter must play a very important part in preventing the germination of seed, the growth of seedlings, and the rapid growth of established plants.

Coastal Morocco, and the greater part of Algeria and Tunisia, have a rainfall between 10 and 20 inches, increasing along the Algerian coast (20 to 40 inches); Tripoli 16, Port Said 3, Alexandria 8, Cairo 1. This falls from October to March or April, especially in December, 80 per cent. of the Algerian rain being received during winter. The coasts of Asia Minor have an annual fall of 20-30 inches; those of Syria and Palestine 20 to 30, received almost entirely from November to March.

Southern Spain (Andalusia) receives 20 to 30 inches, but most of its Mediterranean coast obtains only 10 to 20 inches; Italy, 20 to 40; most of Sicily, 20 to 30; Greece resembles Sicily, but is rather drier The wettest months are in early winter (December or November) in Morocco, Algeria, Tunisia, Syria, Palestine, Asia Minor (coast), southern Sicily; December and February in Syria and the Levant; and October in southern France and Spain, Italy, and the Balkan Peninsula. Rain falls most frequently, though not necessarily, in the greatest amount, from November to January, except in the Riviera and northern Italy, where it occurs in November and April, and least frequently in July or August. Data regarding mean monthly rainfalls at several typical towns, *e.g.*, Genoa, Palermo, Athens, Nice, and Seville indicate that in the Mediterranean portion of Europe most rain falls during autumn and spring in its northern section, and during the winter in its southern portion, as well as along the northern African coast.

The average temperature for the southern Mediterranean littoral and the Levant, during January, lies between the isotherms 50° and 60° F., while most of the European portion lies between 40° and 50° F. In July it all lies between the isotherms of 70° and 80°, while its mean annual temperature lies between 60° and 70° F. We note, then, that the midwinter mean is well below that of the pear region in Australia, though the midsummer mean, as well as the mean annual temperature, agree fairly well. Except for its decidedly colder winter, its temperature conditions resemble those of the pear area of eastern Cape Colony. The amount of rainfall in the greater part of the Mediterranean littoral (except Tripoli, Egypt, and part of Tunisia) would be quite sufficient to allow Opuntias to become a pest if it were received mainly during summer.

We may now briefly review the evidence offered in the preceding statement of the climatological data belonging to (1) the main cactus zone in America; (2) the regions of the world (other than Australia) where prickly pears have become naturalised and have come to constitute a pest; (3) the region where they have

long been naturalised and have not become a true pest; and, lastly, (4) the Australian region.

Practically all pear countries, apart from littoral regions, are in a mixture of grassland and open forest or shrubland, or in the latter. Altitude apparently plays a part insofar as it affects temperature and rainfall, so that a knowledge of the two latter factors need only be taken into account.

The great Opuntia zone of Mexico and the adjacent region of the United States, America, have an average annual rainfall of between 10 and 30 or 35 inches, especially between 15 or 20 and 30 inches, with a marked summer maximum, though, in most places, there are winter falls also. Its annual average temperature is about 70° F. (65°-70°), with midwinter and summer means of 55-60° and 80° respectively. A similar set of climatic conditions has been shown to occur in the chief Opuntia regions of South America. In America the area is bounded approximately by 30° N. (San Antonio, Texas—a homocline of the Hunter-Goulburn valley prickly pear area in N.S. Wales), and by 35° S. (Montevideo, Bahia Blanca), where the pronounced summer character of the rainfall becomes lost and a more or less uniform distribution is experienced—in other words, the northern and southern limits in the New World are similar climatically to the present southern limit of the prickly pear in Australia.

In South Africa, the infected territory lies in a region with an average rainfall between 10 and 30 inches annually (chiefly 15 to 20), which is limited, southerly, by an area receiving uniform or chiefly winter rainfall; and, northerly, by an area whose annual supply is very low. The mean annual isotherms of the area are 62·5° to 72·5° F., with an average annual range from 57° to 85° F

In India the region has a rainfall between 10 and 30 inches (pear being chiefly in the portion with a fall between 20 and 30 inches), increasing along the affected coastal zone. This rain is also received during summer. The mean annual isotherms of the vast area —northern Ceylon to Punjab—are between 77° and 85° F., ranging from 55° (midwinter) to 90° (midsummer mean), the variation being greatest in the Punjab.

The Mediterranean littoral has most of its prickly pear in lands receiving 20 to 30 inches of rain annually, but very little of it during summer. The mean annual isotherms are 60° to 70° F., with mean midwinter and midsummer ranges 40° to 60° and 70° to 80° F., respectively. The mean annual and winter temperatures of the northern coasts are considerably below those of any of the other prickly pear regions, including eastern Australia, and moreover, the winter character of the rainfall is another distinguishing feature.

Probable Future Extension of Prickly Pear in Australia.

We are now in a position to indicate in which direction the advance of the pest in Australia is likely to take place. Species like *O. amyclea* and its relatives may be able to obtain a footing in southern Australia with its Mediterranean climate, but would not constitute a pest, since the abundance of other and more palatable fruit would not lead to widespread utilisation and distribution of such cacti. *O. monacantha* would become a nuisance only in those parts which have a tropical or subtropical climate with a heavy rainfall received largely in the summer, but also a considerable amount distributed throughout the rest of the year; in other words, the conditions that favour a "rain forest" are highly suitable for this species. *O. aurantiaca*, a native of the south-eastern part of the South American pear region, has become acclimatised in the southern portion of the pear region of South Africa and Australia (Darling Downs and Hunter valley) and may be expected to continue to spread in those regions, but will probably not extend northward much beyond its present range. *O. microdasys* from the dry north-central Mexican plateau would probably continue to thrive northwards

from the Pilliga, invading the western portion of the Darling Downs and adjacent plains. Its native habitat has a rainfall between 10 and 20 inches annually, received largely during three months in late summer and early autumn, so that the species would probably thrive in the extensive zone west of the Upper Darling and Warrego in New South Wales and Queensland, respectively, where a similar climate occurs. Of all the Opuntias naturalised in the Commonwealth, this species and *O. imbricata* (from the northern Mexican and Arizona highlands) are the two which would be most likely to spread in the region having a rainfall between 10 and 20 inches received very largely, but not entirely, during summer. A line drawn from Warren through Brewarrina and extending into Queensland, to the west of Cunnamulla, may be taken as a probable southerly and westerly limit for them. They are not likely to become a pest in regions receiving a good rainfall.

O. tomentosa, from the warm parts of southern Mexico, will probably restrict itself to the more northerly portions of our area and show a preference for the coastal region having a rainfall between 30 and 40 inches. There is a long comparatively narrow region a short distance inward from the Queensland coast, and roughly parallel to it, which would suit the species. Both *O. tomentosa* and *O. monacantha* might prove troublesome if they reached the Atherton tableland. *O. megacantha* is now growing in a climate resembling that of its native habitat, and though at present restricted, is capable of considerably widening its range in Queensland and New South Wales. The two species of *Nopalea* are of little importance and not likely to constitute a pest. *O. robusta* would spread in Queensland and northern New South Wales if given the opportunity. Both *O. dillenii* and *O. elatior* are potential pest species, the former being the more dangerous, as it has occupied large areas in the drier and coastal parts of India and Ceylon. It could establish itself practically anywhere around the whole of the Australian coast, as it has done along many tropical shores and on the Mediterranean littoral, but would not become a menace except under climatic and other conditions such as favour the common pest pear, *O. inermis*. This is probably true of *O. elatior* also, which is not, however, a maritime species.

The writer cannot offer any satisfactory reason why *O. maideni* should be so abundant in the Burnett valley and in parts of the Fitzroy valley, while *O. inermis* should be relatively uncommon there. Perhaps the "spiny pear" may have been introduced into that part of Australia, in the first place (just as *O. megacantha* was), and thus obtained a firm footing before the pest pear reached those districts. It seems to prefer a warmer climate than the pest pear, but as the two thrive side by side in the region referred to, it may be assumed that *O. Maideni*, like *O. dillenii*, would be likely to extend into regions which are suitable for *O. inermis*.

Ignoring the question of soil and basing an opinion on climatological evidence, the writer believes that the pest pear *O. inermis*, if left unchecked by biological, chemical, mechanical, or administrative agencies, will be able to extend its range very widely, but only in certain directions. Conditions which favour the formation of a pure savannah appear to be unfavourable for prickly pear. *It will not become a pest south of the line of uniform rainfall; nor in the region where there is a pronounced dry season of five or more months; nor in those parts receiving an average annual rainfall greater than 32 (perhaps 35) inches; nor in the New England tableland and its extensions, on account of the altitude together with the higher rainfall and colder winter. The region south of a line from Sydney to Bourke is not likely to become infested, so that southern and western New South Wales, Victoria, South Australia, and south-west Australia will be outside its future range.* There are no climatological grounds for believing that the Hunter area will not extend westerly to fuse with the area

lying north of Dubbo, and the latter is now joining up with the Pilliga area. The latter may slowly extend eastwards up the Naomi watershed to include the Liverpool plains ultimately, but would extend more rapidly westwards, *i.e.*, down stream. The remaining areas in New South Wales may all become continuous, particularly if heavy floods occur. There may be a slight easterly extension of the northern infested area to form a tongue-like intrusion between Inverell and Bundarra.

It seems probable that if the pear be permitted to spread naturally, its southern limit would remain practically in its present position. It would be bounded by the southern boundary of the Hunter-Goulburn valley (*i.e.*, the Hunter Range) and by a line from its western extremity, passing just north of Gulgong (near Mudgee), Dubbo, Narromine, and Trangie, and probably along the Macquarie River to the Barwon. There might, perhaps, be an extension down the latter river, but it would be held in check by the comparatively low annual rainfall and the high evaporation rate. From the vicinity of the Macquarie-Barwon junction the line may be drawn northward into Queensland, to a point west of Bollon; thence to a point about midway between Wyandra and Charleville; thence north-westerly to the east of Adavale; thence northerly just to the west of Isisford (19·20 inches average annual rainfall), Aramac (18·14), Longreach (17·16), and Muttaburra (18·16), curving north-easterly towards Charters Towers (25·52) and Ravenswood (28·69); thence south-easterly to Nebo (Fort Cooper) and along the range forming the eastern boundary of the Isaacs watershed, and down the Fitzroy valley; from the vicinity of Stanwell or Westwood southwards to the eastern limit of the Dawson valley, extending into the Upper Burnett valley, where the rainfall does not exceed 30 to 32 inches; thence along the Main Range to the New South Wales border, with an incursion into the Brisbane valley, chiefly to the south of the Ipswich-Toowoomba railway line; thence west of the Main Range from the vicinity of Dalveen and following approximately the 2,000 feet contour into New South Wales to the west of Emmaville, Inverell, Tingha, Bundarra, and Barraba, and around the Nandewar Range; thence easterly to the east of Tamworth and Quirindi; westerly around the Warrumbungle Range to Coonabarabran and curving towards Cassilis and Murrurundi; thence along the 2,000 feet contour of the Mount Royal Range to its southern extremity not far from Singleton and Maitland.

The most rapid extension of the area will probably be downstream due to flood waters distributing detached segments, but wide distribution, though at first not so obvious, will probably be effected through birds depositing seeds which pass unharmed through their digestive tract, and are capable of germinating after the summer rains have commenced.

The pest pear would probably thrive at Ravenswood, in North Queensland, but not so well at Charters Towers, and will probably never become a pest in the region lying west of Isisford, Longreach, and Muttaburra, where the rainfall is comparatively light and is of a very pronounced summer type—*e.g.*, Winton, with 15·28 inches average annual rainfall, but with an average of seven successive months each with less than an inch of rain; Ayrshire Downs (16·48), with a similar distribution; Hughenden (19·66), with six consecutive months averaging less than an inch each. Climatically, the districts around Augathella (22·83), Tambo (22·30), Barcaldine (21·67), and Alpha (23·30), all free from pear as yet, are suitable for its active growth. The pest is not likely to extend eastwardly much beyond its present limits in the north, as the pear in the Nebo district (31·96) is only a few miles west of Wandoo Station, which receives 40·81 inches, while to the south of this locality as far as the Hunter River in New South Wales we may reasonably assume that the 32-inch isohyet will mark its

eastern limit as a pest. Great extension to the west of this region is quite possible, so that there may eventually be a very large infested area north of the central western railway line in Queensland. The northernmost area is now becoming fused with the pear region which extends from Stanwell or Westwood to Emerald. Northern and north-western Australia receive a rainfall whose character and amount are not likely to favour the spread of prickly pear, except *O. monacantha* in the wetter regions receiving well-distributed rain, and *O. dillenii* in the drier and coastal zones, where the rainfall is from 20 to 30 inches annually.

A climatological study of the Opuntia regions of the world leads to the conclusion that, if soil conditions be suitable, the pest pear O inermis will be capable of extending very considerably in eastern Australia, especially in Queensland, so that the total invaded area may be nearly three times the area now invaded; while the rest of Australia presents conditions which do not favour the spread of such cacti.

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DESCRIPTION OF PLATE XXV.

Photographs of *O. maideni* (from Degilbo, Burnett River) showing habit of the species. The right-hand plant was grown under shade conditions, hence the lack of spines. Scale in inches. (Photograph by H. W. Mobsby.)

FURTHER DISCOVERIES OF PERMO-CARBONIFEROUS GLACIAL FEATURES NEAR HALLETT'S COVE.

By Professor Walter Howchin, F.G.S.

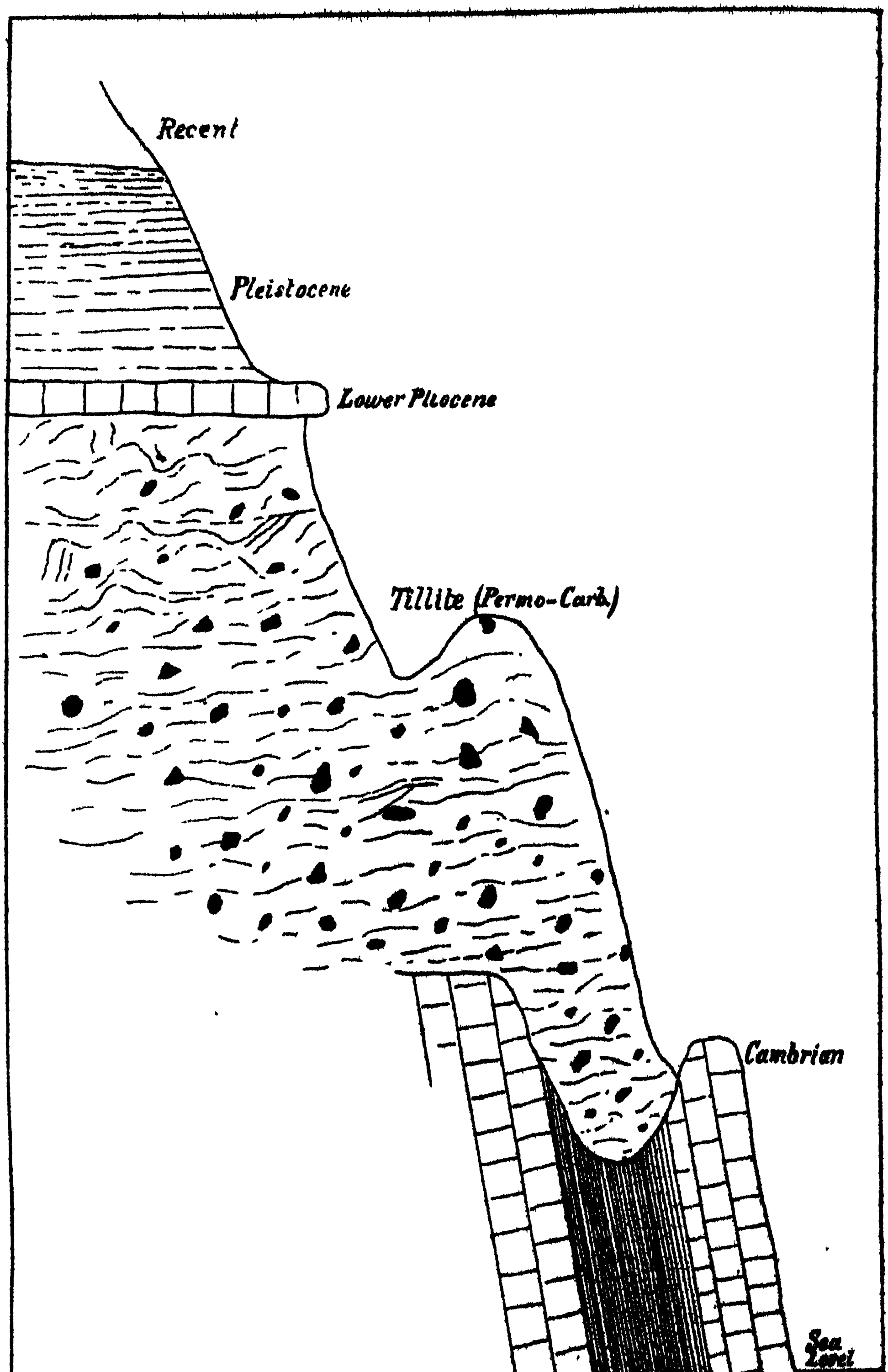
[Read October 9, 1924.]

Plates XXVI. to XXVIII.

The remarkable features that distinguish Hallett's Cove as one of the most picturesque and interesting localities on the coast have concentrated attention on the broken ground of the amphitheatre and the historic polished surface of purple slate discovered by the late Professor Tate. It had long been taken for granted that the indications of ice action came to an end on the northern side of the outlet of the small creek that reaches the coast a quarter of a mile to the northward of Black Point. A recent examination of the ground has proved that this is not the case. Exposures of the tillite and very fine examples of polished and striated surfaces that formed the bed of the glacier can be traced along the top of the cliffs, more or less continuously for another half a mile. The polished surfaces, in this direction, differ entirely from those found near Black Point. In the latter case the floor over which the ice moved consisted of purple slates which, although easily scratched and furrowed, weather rapidly on exposure and the glaciated surfaces are soon obliterated by a process of exfoliation and flaking; but northward of the small creek just mentioned, the ice moved over a floor of quartzite on which the ice-marks have a better chance of being retained

From Black Point, northwards, a well-defined anticline occurs in the Cambrian Series having its axis situated a little inward from the coast with its western limb dipping steeply to the westward in the sea cliffs. At Black Point the cliffs consist of very dark-coloured purple slates, but nearer the axis of the anticline the fold includes some hard siliceous quartzites. The general strike of these beds is a little more westerly than the alignment of the coast, so that the beds gradually run out on the cliff face and beds nearer the axis of the fold take their place in succession. In accordance with this stratigraphical feature the purple slates of Black Point run out to the seaward, at about the intersection of the first creek northward of Black Point, and are replaced by quartzites separated by layers of purple slates. This gives rise to an unstable condition in the rock structure when exposed to wave action, so that the line of cliffs along the stretch of coast, dealt with in the present paper, is repeatedly broken. The hard layers of rock form angles by the retreat of the cliff on the northward side, the following softer bed yielding and the next underlying hard bed forms the cliff, until it also is truncated, in its turn, with another set back of the cliff to the northward. In this way the sea cliffs exhibit a succession of rock faces at right angles to the coast, occasioned by the retreat of the adjacent cliff, having some resemblance to the teeth of a saw. By this form of cliff-structure the hard members of the series form the edge of the cliffs in a zig-zag fashion, and it is these hard outcrops that carry the polished and striated features which indicate the path of the glacier.

The change in the nature of the sea cliffs, from purple slates to that of a close-grained quartzite, begins on the northern bank of the creek mentioned above. The rock is here slightly glaciated, as had been previously noted, but only for a few yards, and then the glacial striae appear to be cut off in a direction



Geological Section seen in sea cliffs near Hallett's Cove.

seawards, from which point the quartzite rock is much broken and sinks down to a small gutter which breaks the continuity of the cliffs, at about 40 yards northward of the creek mentioned No glacial features were supposed to exist beyond this point.

The tillite is well exposed in the small gutter, just referred to, and on its northern side is a large tabular-shaped erratic of Tapley's Hill ribbon slate measuring 4 feet by 4 feet, wedged in at the very edge of the cliff

At a further distance of 55 yards, near the next prominent angle in the cliffs, is a round boulder of gritty limestone, measuring 2 feet 6 inches, derived from a characteristic bed of the Cambrian Series, above the Brighton limestone horizon Near the same spot a small erratic of the ilmenite grits, derived from the basal beds of the Adelaide Series, was noticed

Some 40 yards further to the northward, the quartzite, forming the top of the cliffs, is glaciated and continues to show such features for a considerable distance.

At about 150 yards from our starting point there occurs the most complete section of the tillite with its associated rocks contained within the limits of the Hallett's Cove outlier, and, probably, so far as the State is concerned (see text fig. and pl xxvi) The beds included in the section belong to five distinct geological ages, as follow, beginning with the oldest —

1. The bed rock is of Cambrian age forming part of the Purple Slates Series It consists mainly of quartzites that form the sea cliff having a steep dip to the westward Height above sea level	40 feet
2 Resting on a Cambrian floor is the tillite, or boulder clay, which has the character of an argillo-arenaceous deposit, varying in colour as yellowish, bluish, or of purple-like tint, finely laminated, sometimes passing into a clayey sandstone The bed, in places, has undergone considerable contemporaneous contortions This can be best seen near its upper limits, where the purple-coloured layers, or streaks, are pushed up into folds, and even forced, in blocks, into a perpendicular position The uppermost 9 feet of the tillite partakes of the nature of a yellowish clayey-sand, penetrated by thin streaks of purple-coloured clay that occur at various angles Estimated thickness	65 feet
3. Resting directly on the tillite is a strong bed of fossiliferous, gritty sandstone, of Lower Pliocene age The fossils, which are present in great numbers, are mostly in the form of impressions and casts The large foraminifer, *Orbitolites complanata*, is very common Thirteen examples of this form were counted on a single slab, varying in size up to an inch in diameter. Thickness of bed ..	3 feet
4. The newer formations, in ascending order, are Pleistocene mottled sandy-clays, grits, and gravel (20 feet) overlaid by Recent reddish clays, travertine, and blown sand that form a grassy slope Estimated thickness	50 feet

The tillite in the above section is partly obscured by large blocks of the fossiliferous sandstone which have slid down from their proper position and, also, by blown sand from above.

On the northward side of the section, just described, there is an angle in the cliffs with a way down to the rocks below This break in the cliffs is connected with a deep ditch that has been excavated by the glacier and is now filled with boulder clay. The overdeepening that took place at this spot arose from the presence of a stratum of purple slates, about 12 feet in thickness, in the bed rock, which yielded more readily to the erosive action of the glacier than the quartzites on either side. The respective walls are glaciated. Some small rivulets have washed the boulder clay from the face of the purple slates exposing two glaciated faces with a western aspect, measuring, respectively, about 4 square feet and 8 square feet. About half-way down to the rocks, on the beach, is an erratic of dark-coloured felspar porphyry, about 14 inches in length; and, at a lower level, within tide limits, is a granite erratic of the Victor Harbour type, coarse-grained, pinkish, with porphyritic inclusions of felspar crystals, 2 inches in

diameter. The boulder measures 3 feet 4 inches by 2 feet. At a higher level, on the face of the tillite, is a group of erratics obtained from the Sturtian tillite, five or six in number, the largest of which measures 3 feet 6 inches in length.

About 70 yards further to the northward the sea cliffs are once more broken and set back a few yards. Some of the most interesting features of the locality occur at this point. The glacially eroded ditch, mentioned above, is more clearly defined at this spot. So far as the present features are concerned the ditch has very unequal sides. The western wall is formed by what is left of the outer cliff which is heavily glaciated from the top to the bottom of the hollow, a depth of about 12 feet. In its upper portion, the quartzite, in a polished face 10 feet in length, is very strongly striated and grooved (see pl. xxvii., fig. 1). Unfortunately a portion of this very fine glaciated surface has been overgrown by lichens, which have not only obscured the glacial features beneath, but, by their disintegrating action, have obliterated them. The eastern wall of the ditch is about 25 feet in height, the upper portion of which is bared to a depth of 9 feet, the surface of which is glaciated.

Twelve yards further to the northward there is still another break in the cliffs with a truncation of the outer cliff and formation of another by retreat. Here, again, are seen the two opposing glaciated faces, the one facing west and the other facing east. At a low level the purple slates are visible, showing polished surfaces, and at a higher level the quartzites are glaciated over an extensive surface (see pl. xxvii., fig. 2). The junction between the polished surface and the unglaciated portion, in a straight line, is very clearly defined. It was on the landward side of this spot that the photograph of the tillite (pl. xxviii., fig. 1) was taken.

Travelling northward, along the quartzite outcrop, the rock surfaces are polished and, practically, continuously so for a distance of 90 yards. Then, for about an equal distance, the surface of the cliff is more or less broken and the glacial features are indistinct.

About the position indicated in the last paragraph a very large erratic occurs on the top of the cliffs, not many yards from their edge. It is an impure, earthy limestone, that measures 8 feet 6 inches in length, 6 feet 6 inches in breadth, and is 3 feet 4 inches in height (pl. xxviii., fig. 2). It was derived from the Impure Limestone Series that underlies the Brighton main limestone.

At a distance of 35 yards from the erratic, just described, the most important break in the cliffs, within the area under description, occurs. The cliffs, here, retreat for a distance of 20 yards, on a sharp angle, and have a height of 30 feet above those immediately to the southward. The truncated portion of the outer cliff is glaciated, but no evidence could be found of any ice marks on the higher cliffs, either on the cliff edge or of boulder clay to the landward.

Broken, rocky ground continues for 200 yards, when the land slopes down to a small creek that has formed a succession of waterfalls in cutting its way through the hard rocks to the beach. The quartzite, that forms the termination of the cliffs on the southern side of this creek, is glaciated with a small amount of tillite banked against it. These were the last vestiges of the path of the glacier noticed in that direction, the quartzite quickly gives place to soft purple slates which fail to retain ice marks for any length of time.

The Tillite.

The tillite forms a continuous deposit from Black Point to the large erratic shown on pl. xxviii, fig. 2). It forms the lower slopes of the secondary cliffs that rest upon the peneplained Cambrian rocks, but the face of the tillite is largely obscured by more recent clays and blown sand carried down from higher levels.

Surface wash and small rain gutters have removed the covering, in places, so that the tillite can be easily followed.

In composition and structure the tillite is a finely laminated argillaceous deposit, mostly a greyish and bluish soft shale in its lower portions, with more or less purple-coloured layers and bands, especially in the upper parts. Bands of a sandy nature occur at intervals and are usually of a yellowish colour. It has undergone contemporaneous contortion at some horizons, which is especially noticeable near its upper limits. This feature may be associated with the retreat of the ice which may have been subjected to seasonal retreats and advances. A typical illustration of the boulder clay is reproduced in pl. xxviii., fig. 1.

The Erratics.

The tillite is not particularly either stony or gritty in its composition as a whole. Considerable portions seem almost destitute of stones, while, in other places, erratics are common. A classification of the erratics brings out some interesting particulars. They may be roughly placed in two sections with respect to their origin.

1. *Erratics that are far-travelled.* These include granites of various types, some fine-grained, but the greater number are coarsely crystalline with large felspar inclusions showing a close resemblance to the porphyritic granite of Western Island, near Victor Harbour. A few examples of a dark-coloured felspar porphyry were noted, and a large block of white quartz-rock, 28 inches in length, occurs, forming a conspicuous object on a grassy slope of the secondary cliff.

2. *Erratics that have had a more local origin* These comprise, by far, the greater number of those present in the tillite, and include examples quarried from the principal outcrops of the Adelaide Series. A typical example of the ilmenite grits, that form the base of that series, was observed. Several large blocks of quartzite of the Glen Osmond and Mitcham type occur. One of these, situated on the same knoll as the white quartz-rock, mentioned above, measures 4 feet 6 inches by 3 feet, which is used by the sheep as a shelter and as a scratching stone. One example of the Sturtian tillite was observed at the southern end of the line of cliffs and a group of five, as described above The Tapley's Hill ribbon-slate is moderately common, but easily splits up on the cleavage planes, showing that this structural feature of the rock antedates that of the Permo-Carboniferous Period—an example seen was glacially smoothed and striated. Some large blocks of the siliceous and slaty limestones belonging to the lower members of the Brighton Series occur, one of which is shown on pl. xxviii., fig. 2. It is the largest erratic seen on this part of the coast, and, like the larger quartzite, mentioned above, forms a shelter for the sheep. Quartzites of a purplish colour found in the tillite must have been ploughed up from the immediate bed rock on which the tillite rests. The local purple slates were too soft to form distinct erratics, but have been ground down to form a very large proportion of the argillaceous material that makes up the greater part of the tillite. Dark-coloured shales or slates make up a considerable proportion of the erratics which have probably been derived from the beds of the Adelaide Series, but are not sufficiently characteristic to be referred to their respective horizons.

These locally derived erratics indicate that the ice must have travelled from a S.S.E. direction, crossing the country through which the Onkaparinga and Field Rivers now flow. It is worthy of note that no true limestones have been recognised among the erratics. The Brighton limestone, over which the glacier must have passed, makes only a small feature in the outcrops, so that the absence

of erratics obtained from the horizon need not cause surprise, but the Archaeocyathinae and associated limestones, of the Willunga ranges, are of much greater extent, and if at the surface at this period of glaciation should have yielded their quota in the transported material. Their absence from the tillite can, however, be easily accounted for. The limestones referred to have been brought to the surface by the block-faulting of the Mount Lofty and associated ranges. The downthrow of the Mount Lofty block and the upcast of the Willunga ranges have exposed these beds along the fault scarp, a geological event that is of, comparatively, recent date, so that at the time of South Australia's ice-age these beds were deep-seated and far beyond the erosive action of the ice

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DESCRIPTION OF PLATES XXVI. TO XXVIII.

PLATE XXVI

A face of Tillite capped by a bed of fossiliferous Pliocene. The photograph takes in about one-third of the glacial beds included in the section. The large stones seen in the picture have fallen down on the face from the Pliocene cap.

PLATE XXVII.

Fig. 1 Glaciated Quartzite, 10 feet in horizontal length. Forms a part of the western side of the glacial ditch. The upper part is obscured by algae growths The black vertical and horizontal portions are cracks and cavities in very dark shadow.

Fig. 2. Glaciated Quartzite on eastern side of glacial ditch. Note the sharp line of distinction between the glaciated upper surface and the rough face where the rock has been fractured.

PLATE XXVIII

Fig. 1. An exposure of Tillite under weathering. Two granite boulders are seen near the centre.

[As proof of the rapid change of features on this face (which is rather steep and near the edge of the cliffs), on visiting the spot a few weeks after the photograph had been taken one of these granite boulders was missing. In another visit, a week or two later, the second granite boulder was gone. Wind and rain-wash had carried them over the cliffs and they are now at the base of the latter.]

Fig. 2 An Erratic of shaly Limestone (end view) measuring 8 feet 6 inches by 6 feet 6 inches, by 3 feet 4 inches high.

[All photographs are by the author.]

ANTHROPOMETRIC AND DESCRIPTIVE OBSERVATIONS ON SOME SOUTH AUSTRALIAN ABORIGINALS, WITH A SUMMARY OF PREVIOUSLY RECORDED ANTHROPOMETRIC DATA.

By F. Wood Jones, D.Sc., and T. D. Campbell, D.D.Sc.

[Read October 9, 1924.]

Plates XXIX. and XXX.

No apology is needed for recording in a short paper the complete measurements of only a few individuals, when these individuals belong to the most rapidly vanishing section of a dying race. The task of securing full anthropometrical data is becoming progressively more difficult as time goes on, and, unfortunately, we are already too late to embark on any satisfactory study of the natives of the southern portions of this State.

Only ten individuals have been passed in review for the purpose of this paper; nevertheless, though the number of subjects is small the range of observations and measurements is fairly comprehensive, and it cannot be said that these observations are in any way redundant in view of the very scanty literature dealing with the anthropometry of the Australian Aboriginal

The first eight subjects were measured and examined by the authors during a trip made to the Stuart Ranges in 1923. These eight subjects were members of the Kookata tribe—a tribe that will before long cease to exist in its pure blood. Of the eight Kookata five are males and three females, and since the observations were made one of the males, the then recognised head of the tribe, has died. The remaining two subjects, a male and female, were measured and examined in Adelaide, whither they had been brought as witnesses under police escort, from Streaky Bay in 1923. For kind permission to conduct this examination we are indebted to the police authorities, from whom we received every assistance. In the case of the Kookata natives we are under a special debt to the Messrs. Jacob Brothers, on whose head station at Mount Eba the examination was conducted.

Instruments employed.—In all cases Professor Rudolph Martin's stature rod, spreading calipers and sliding compasses—made by P Hermann, of Zurich—were used. In addition, a millimetre, non-metallic, measuring tape was employed in certain measurements. The whole examination was conducted strictly under field conditions, the subjects being studied and examined in the open whenever and wherever opportunity could be found. The photographs, also, were necessarily field snapshots rather than studio studies of the subjects.

Measurements recorded.—The records taken represent an eclectic series culled from the full set suggested by the Monaco Conference (1906), and for the purpose of the present enquiry the works of Ales Hrdlicka, H. H Wilder, and L. R. Sullivan have been taken as guides. All the observations recorded are of importance, but the experience of the present authors has convinced them that some of these measurements, when obtained under anything less than ideal conditions, are liable to a considerable degree of error. In certain cases nothing short of a prolonged and intimate overhaul of the completely nude subject can

accurately determine the exact measuring points. In the conditions under which field work among partly civilised and abundantly clothed natives has to be undertaken some uncertainty must attach to the identification of certain of the bony landmarks necessary for complete anthropometric work. It must be remembered that measurements have to be made under these conditions or they will not be made at all. We may have to contend against the embarrassment of a multitude of petticoats and trousers at the present day, but unless we are prepared to do this we must be content to watch with folded hands several tribes pass unmeasured and unrecorded into oblivion. Again, as every surgeon knows, obesity, a common condition of "station blacks," renders the isolation of bony measuring points a matter of some uncertainty. Nevertheless, despite the drawbacks of ample clothing and occasional obesity, we feel that the measurements recorded in our little series are as accurate as patience, some little experience, and the possession of good instruments can render them. For the use of the instruments we are indebted to the Board of Governors of the Museum, etc.

Subjects examined.—The individuals examined have, unfortunately, to be designated by white man's or station names, the native names not being obtainable. The following is a list of the individuals examined; they are distinguished by a letter by which they are designated in the table of measurements. The first eight individuals (A—H) are Kookata measured at Mount Eba; the remaining two (I and J) are Ngunga, from Streaky Bay:—

A. Yungun.
B. George Mitchell (then recognised head of the Kookata, now deceased).
C. Sugar Billy, from the west of the Kookata region.
D. Long Fred, son of C.
E. Dorothy, daughter of C.
F. Jinny.
G. Charlie.
H. Edie, from Tarcoola.
I. Annie Wombat, } Wife and Husband.
J. Dick Wombat, }

Anthropological Obsrvations recorded.—In addition to the measurements, a series of notes was made on each subject examined. These notes include the following details:—Colour of skin, eyes, and hair; hirsuteness of face and body and characters of the scalp hair; the condition of the teeth, and the presence, site, and type of cheloid scars.

In the case of colour descriptions we were handicapped by lack of standard colour guides; but as far as possible we have recorded our observations in accordance with the suggestions of Hrdlicka. Samples of hair were taken for histological examination and finger prints were recorded. Photographs, full face and profile, were taken of each subject. The ages recorded are necessarily only approximate.

TABLE I

No.	Sex	Age	Skin colour	Eye colour	Hair colour	Hirsuteness			Head hair	Teeth	Cheloide scars	Remarks
						Face	Chest	Forearm				
A	Male	40	Dark chocolate	Dark brown	Black	Whiskers and moustache	Marked	Marked	Low waves	All good	Hip	
B	Male	60+	Dark chocolate	Dark brown	Black	Whiskers and moustache	Marked	Marked	Almost straight on top terminating in ringlets	A number missing and carious	Chest	
C	Male	50+	Dark chocolate	Dark brown	Black	Whiskers and moustache	Marked	Scant	Low waves	Good	—	Hole in nasal septum
D	Male	25	Dark chocolate	Medium brown	Black	Whiskers and moustache	Medium	Medium	Fairly straight (had been cut)	Some carious	—	
E	Female	16 18	Dark chocolate	Medium brown	Black	Nil	Nil	Nil	Low waves	All good, M_3 unerupted	—	
F	Female	Aged	Dark chocolate	—	White	Nil	Nil	Nil	Very low waves	—	—	
G	Male	Aged	Very dark chocolate	Dark brown	White	Whiskers and moustache	Marked	Marked	Bald on top of head, otherwise low waves	Good, right upper central incisor removed	—	Tufts of black hair on ears 50 mm. long
H	Female	25 30	Medium chocolate	Dark brown	Black	Beard and moustache fairly marked for a female	—	—	Low waves	Good	—	
I	Female	19	Light chocolate	Dark brown	Black	Nil	—	—	Wavy with terminal spirals	All present	—	
J	Male	23	Medium chocolate	Dark brown	Black	(Shaves)	Scant	Scant	Low waves	Some carious	—	Lips not so everted as in I

Measurements recorded.—Thirty-five measurements were taken of each subject. In the table these measurements are numbered from 1-35, the actual measurements indicated by the numbers being as follows:—

Body	1. Stature.
	2. Shoulder height.
	3. Height to supra-sternal notch.
	4. Sitting height.
	5. Arm span.
	6. Breadth across shoulders.
Head	7. Length.
	8. Breadth.
	9. Height (auricular-bregmatic).
Face	10. Length (menton-nasion).
	11. Height (menton-crinion).
	12. Breadth (maximum bizygomatic).
	13. Diameter (minimum frontal).
	14. Diameter (bigonial).
	15. Maximum interorbital.
	16. Maximum intercanthal.
	17. Minimum intercanthal.
	18. Bi-orbito-nasal arc.
Nose	19. Height.
	20. Breadth
	21. Length.
Mouth ..	22. Breadth.
Ear	23. Length.
	24. Breadth.
Upper Limb ..	25. Total length (with hand).
	26. Length upper arm.
	27. Length forearm.
Hand	28. Length.
	29. Breadth.
Lower Limb ..	30. Total length (to sole).
	31. Length (without foot)
	32. Length of thigh.
	33. Length of leg.
Foot	34. Length.
	35. Breadth.

All measurements are recorded in millimetres.

Note on nose measurements.—In reviewing the literature of anthropometry it becomes evident that some confusion exists as to the terms "nasal length" and "nasal height." In the present paper the authors have used the term nasal height for the measurement from the nasion (n) to the subnasale (s), and nasal length for that from the nasion to the point of the nose, pronasale (prn). By this usage, which is advocated by the British Association Anthropological Committee (1909), the terms are kept distinct. In accordance with this usage, the figures given by Spencer and Gillen and Stirling as representing "nose length" have been placed in our comparative tables under nasal height, in order to obtain uniformity. The full table of measurements is as follows, the individuals being represented by the letters A—J and the measurements by the numerals 1-35:—

Table II.

Subjects.

Observation	A	B	C	D	E	F	G	H	I	J	Max.	Min.
1	1660	1675	1595	1787	1616	1481	1580	1596	1480	1616	1787	1480
2	1390	1435	1358	1544	1372	1260	1336	1374	1240	1368	1544	1240
3	1370	1400	1312	1512	1391	1223	1302	1337	1210	1330	1512	1210
4	843	805	746	853	795	682	768	794	736	837	853	682
5	1705	1823	1705	1940	1684	1527	1630	1705	1475	1677	1940	1475
6									325	385	385	325
7	196	192	196	200	178	180	196	181	165	188	200	165
8	145	141	.141	146	135	137	143	134	130	144	146	130
9	122	125	124	117	125	123	116	135	112	130	135	112
10	107	110	114	115	101	86	106	93	85	118	118	85
11	182	192	193	195	167	170		173	165	196	196	165
12	137	141	131	131	127	123	143	136	120	142	143	120
13	119	111	109	116	106	110	116	120	104	116	120	104
14	117	114	100	112	95	91	86	107	97	106	117	91
15	110	112	100	113	110	97	108	112	97	116	116	97
16	94	91	87	104	97	85	99	94	90	102	104	85
17	39	35	36	38	33	34	32	37	34	35	38	33
18	145	120	116	145	130	125	135	137	125	145	145	116
19	45	48	56	52	40	41	46	36	35	47	56	36
20	50	52	52	45	40	42	50	45	36	51	52	36
21	44	42	52	50	39	34	46	35	33	44	52	33
22	67	58	65	58	58	62	70	55	48	64	70	55
23	65	67	67	62	59	58	74	64	56	58	74	56
24	36	40	40	33	32	32	33	34	27	32	40	27
25	760	784	760	875	733	637	710	730	620	700	875	620
26	325	372	317	383	312	340	287	310	280	308	372	280
27	253	290	251	313	258	258	256	260	238	250	313	238
28	198	195	187	215	187	172	200	185	165	181	215	165
29	82	81	86	86	70	67	80	80	66	75	86	66
30	880	940	931	1022	940	885	873	980	922	925	1022	880
31	824	887	885	956	887	834	804	940	864	860	956	804
32	447	435	449	495	455	394	393	480	454	470	495	393
33	377	452	439	460	432	440	411	460	410	390	460	377
34	250	265	261	282	250	232	254	244	221	246	265	221
35	88	100	92	100	91	74	90	100	75	100	100	75

In order to render these figures more useful to students of physical anthropology, we have thought it best to draw upon the work of previous observers, and in this way to present a more complete picture of the numerical facts of the physical form of the Australian Aboriginal. Measurements that are presented in the form of isolated tables of figures are, of course, of vital importance, but they have not achieved their full utility when left in that form. For this reason we have, with permission where possible, extracted mean values and several indices from the measurements compiled by others, and presented these in a manner comparable with our own, thus making a composite picture of the measurements of nearly two hundred individuals. The source of previous recorded measurements of Australian Aboriginals of which we have been able to avail ourselves are as follow:—

(1) Dr. Roy Burston.
 Bulletin of the Northern Territory of Australia.
 Bulletin No. 7A, July, 1913.

(2) Spencer and Gillen.
 The Native Tribes of Central Australia, 1899. Appendix C, p. 644—our "List I."

(3) Spencer and Gillen.
 The Northern Tribes of Central Australia, 1904. Appendix A, p. 766—our "List II."

(4) E. C. Stirling.
 The Horn Expedition, vol. iv., Anthropology, pp. 140, 141.

(5) R. Brough Smyth.
 The Aborigines of Victoria, vol. i., pp. 1-4.

Among these sources of information the work of Burston stands out pre-eminently for its thoroughness and its scope. No less than 82 measurements were taken of each individual, and over 100 individuals were examined. It seems evident that this extremely important piece of work has not had the recognition it deserves, and it is worth mentioning that no copy of the paper appears to be available in any educational institution in Adelaide. Burston's measurements, though unfortunately little known to anthropologists in general, form the backbone of our knowledge of the anthropometry of the Aboriginal, and it is unlikely that such another contribution to the literature of this subject will be forthcoming unless financial aid and administrative encouragement are one day given to the study of the Australian Aboriginal. In Table III. a survey of the results of the present writers, and those obtained by previous workers, is recorded. The columns give the mean of measurements taken from the total number of individuals examined, and also for the males and females separately. The number of adults embraced in these tables is as follows:—

		Males.	Females.
Wood Jones and Campbell	Total 10	6	4
Burston	Total 93	62	31
Spencer and Gillen (1)	Total 30	20	10
Spencer and Gillen (2)	Total 40	23	17
Stirling—For stature only	Total 50	39	11
For complete measurements	Total 1	1	—
Brough Smyth—For stature only ..	Total 86	60	26

Totals—For complete measurements, 174—Males 112, females 62.
Totals—For stature only, 309—Males 210, females 99.

The blank spaces in the tables indicate that the measurement was either not taken by the earlier observers or else was not in accord with the standard requirements followed by the present writers.

Table III.

Comparative Table of Mean Values.

Observation	Wood Jones and Campbell			Spencer and Gillen List I			Spencer and Gillen List II			E. C. Stirling			R. Burston		
	Total	Male	Fem	Total	Male	Fem.	Total	Male	Fem.	Total	Male	Fem.	Total	Male	Fem.
1	1608·6	1652	1543	1631·8	1663	1568	1662·3	1714	1591	1599	1671	1543	1660·7	1706	1570
2	1367·7	1572	1311	1366·7	1397	1304							1381·9	1418	1310
3	1338·7	1538	1290	1354	1383	1296	1381·3	1425	1322		1370		1382·9	1405	1338
4	785·9	809	752	773·4	780	760	792·5	817	759		773		802	822	762
5	1687·1	1747	1598	1685·4	1723	1610	1761·8	1815	1688		1545		1719·3	1779	1600
6	355·0	385	325				322·4	334	305				341·7	358	310
7	187·2	195	176	186·6	189	180	188·5	192	183		198		188·1	192	180
8	139·6	143	134	139·8	141	136	135·3	138	131		138		137·7	140	133
9	122·9	122	124				127·6	131	122		114		132·6	135	133
10	103·5	112	91	79·2	82	73	110·7	115	105				112·3	117	103
11	181·4	192	169	187·6	196	170									
12	133·1	137	126	138·5	142	131	128·6	133	122		138		135·4	139	127
13	112·7	114	110	108·4	109	107							111·4	112	109
14	102·5	106	97	97·1	98	94	101·2	105	96				102·5	105	96
15	107·5	110	104				105·8	107	103				103·7	106	99
16	94·3	96	91				93·4	94	91				92·4	94	89
17	35·3	36	34				34·2	35	33				35·9	37	35
18	132·3	134	129				122·9	124	121				121·1	124	114
19	44·6	49	38	49·6	51	46	47·2	48	45		53		47·6	49	45
20	46·3	50	41	46·8	48	43	49·1	51	46		46		44·4	46	41
21	41·9	46	35										40·9	42	38
22	60·5	64	56												
23	63·0	65	59				64·1	66	62				62·6	64	60
24	33·9	36	31				36·7	38	35				34·1	35	33
25	730·9	765	680	764·7	781	730	789·6	812	760		729				
26	323·4	332	310										321·7	334	297
27	262·7	269	253										256·9	266	238
28	188·5	196	177										171·9	177	163
29	77·3	82	71										76·3	79	71
30	929·8	928	932	891·3	917	833									
31	874·1	869	881												
32	447·2	448	446										441·9	454	417
33	427·1	421	435										393·5	405	371
34	250·5	260	237	245·3	251	234					247		249·3	259	231
35	91·0	92	90										96·6	101	88

In Table III. it is to be noted that the figures given by Spencer and Gillen in List I. for the facial length—observation No. 10—are so different from those recorded by the present authors and by Burston as to suggest the use of different measuring points. However, the same measurements taken by the same authors, and recorded in List II., are so nearly in harmony with our own as to render the explanation of the low values in List I. uncertain.

Stature.—A great many more observations have been made on stature than on other body measurements, since many observers who have not had the advantage of a complete anthropometric outfit or have lacked a knowledge of the other body

measurements usually recorded, have measured the total standing height of subjects. Brough Smyth records the following figures:—

	No. of Individuals.	Mean.
Total	86	1626·4
Males	60	1671·3
Females	26	1522·5

Topinard in his "Anthropology" (1890, pp. 320, 321) gives the following figures for the stature of Australian Aboriginals. The total number of individuals and the sexes are not recorded:—

Topinard's observations	1,718
Lesson's observations	1,575

Using all the available records sufficiently precise to be of any scientific value we may record the mean values for a few of the more important observations. These figures are founded on a fair number of individual measurements, and the business of abstracting the means of all available data is being continued by the present writers: —

Observation.	Total individuals.	Mean.	Total males	Mean.	Total females	Mean.
Stature ..	309	1636·9	210	1684·8	99	1557
Cranial length	173	187·9	112	191·9	61	168·8
Cranial breadth	173	137·6	111	140·1	62	133·1

Indices.—We have worked out the mean values of a number of indices derived from our own measurements. For comparison with the results obtained by others, dealing with individuals of other tribes, we have worked out the mean values of some of the cranial indices from the figures recorded by other observers.

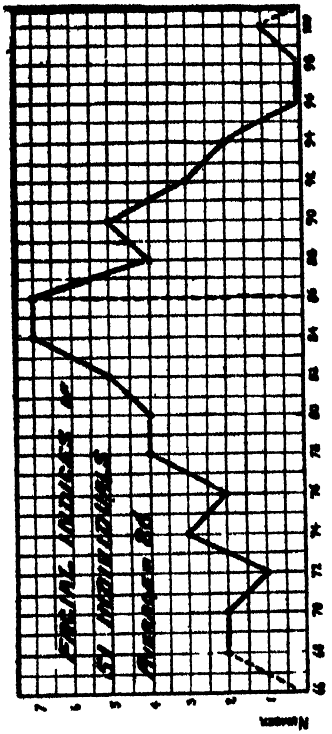
This work is still in progress, and for the present has been limited to the most apparently important measurements.

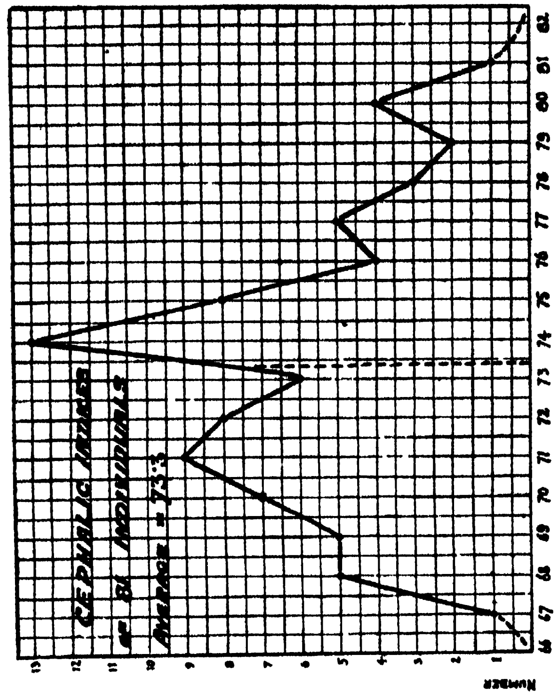
Arithmetical Mean of Indices.

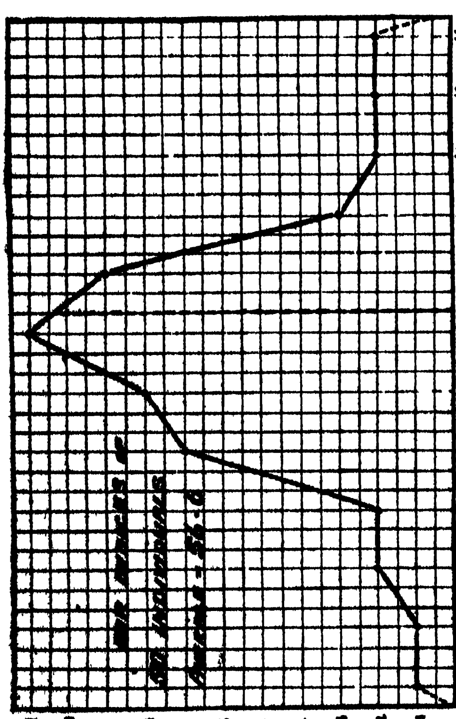
	Wood Jones and Campbell		Spencer and Gillen List I.		Spencer and Gillen List II.		E. C. Stirling	
	Number of individuals	Mean	Number of individuals	Mean	Number of individuals	Mean	Number of individuals	Mean
Cephalic ..	10	74 6	30	75	40	71 8	1	69 6
Facial .	10	77 5			40	86·5	1	71·7
Nasal ...	10	104·6	30	94·7	40	104 6	1	86·6
Ear	10	53 8			40	57·3		

From our own observations alone we have abstracted a few more, indices, and these, like the last, must be regarded only as a preliminary contribution. We have for the present confined ourselves to certain body and limb measurements in order to obtain, if possible, a concrete idea of the mean body and limb proportions of the Australian Aboriginal:—

Arm—Stature index	45·3
Leg—Stature index	57·8
Radio—Humeral index	81·4
Tibio—Femoral index	95·9


FACIAL INDICES OF
51 INDIVIDUALS
AVERAGE 84
NUMBER
INDEX


CEPHALIC INDICES
OF 81 INDIVIDUALS
AVERAGE = 73.3
NUMBER
INDEX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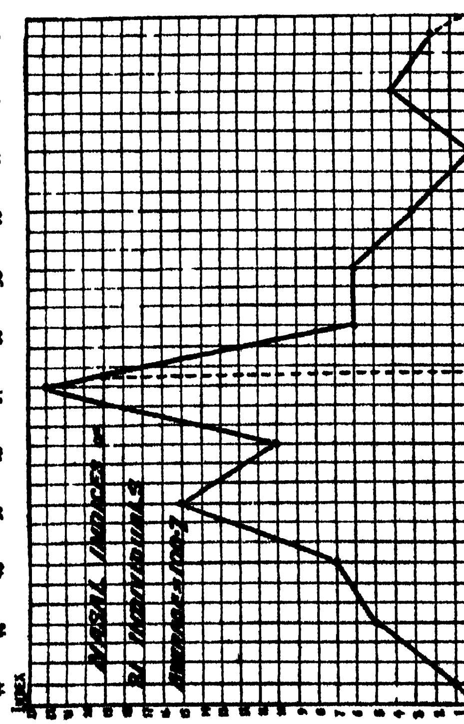
NASAL INDICES OF
81 INDIVIDUALS
NUMBER
INDEX

From the indices that have so far been completed it will be seen that the Australian Aboriginal falls into the following classification groups:—

Head form, dolichocephalic.
Nose form, markedly platyrhinic.
Radio—Humeral index, dolichokerkik.
Tibio—Femoral index, markedly dolichocnemic.

Expressed in another way, we may say that we have now a sufficient numerical basis to guarantee the assertion that the Australian Aboriginal has a long head; he has a remarkable widespread nose, long forearms, and remarkably long legs from the knee downwards.

In order to make some of our results clearer we have represented them in graphic form as frequency curves. These curves include the indices for ear, face, nose, and head, and embrace the observations given in the above table of Arithmetical Mean of Indices.

In this paper we have made no attempt at instituting comparisons between the figures we have obtained and the indices we have worked out from all recorded observations and similar values recorded for other races. All this must come later. Meanwhile we would express the hope that the burden we have undertaken of keeping a record of the anthropometric observations made on the Australian Aboriginals will become an increasingly irksome business. It is surely a remarkable thing that all over the southern portion of South Australia a native population has passed, or is rapidly passing away, without any satisfactory record ever having been made of the simplest measurements of the bodily form. It is high time this was remedied, and as a step towards the remedy these results—a tithe of what is requisite and due—are recorded.

Note on Finger Prints.

Finger prints of all ten individuals examined by us were recorded. Through the kindness of Commissioner Leane these were submitted for examination to the experts of the Criminal Investigation Department. Mr. F. E. Brice, of the C.I.D., has reported that the finger prints of the group of natives here considered show a condition entirely in accord with all other prints of Aboriginals which he has examined, their characteristic feature being consistent whorls.

EXPLANATION OF PLATES XXIX. AND XXX.

Plate XXIX.

Full face and profile photographs of (from left to right) subjects A, B, C, and D.

Plate XXX.

Full face and profile photographs of (from left to right) subjects E, F, G, and H.

THE CHITON FAUNA (POLYPLACOPHORA) OF PORT STEPHENS, NEW SOUTH WALES.

By Edwin Ashby, F.L.S., M.B.O.U.

[Read June 12, 1924.]

Plate XXXI. (in part).

Port Stephens, as far as we have been able to ascertain, has never been thoroughly explored for Polyplacophora. The only record, we were aware of, of work done in this neighbourhood is a note by A. F. Basset Hull, in his paper on "New Australian Polyplacophora and Notes on the Distribution of certain Species" (Austr. Zool., vol. iii., 1923), in which he states, *inter alia,* "I have examined Port Stephens . . .", but no further mention is made. Subsequently, in the same paper (p. 164), in reference to *Rhyssoplax carnosus,* Angas, he writes, "It has been my good fortune to examine . . . examples from Port Stephens." Apparently these are the only published notes on the chitons of this vicinity.

The advance party, consisting of W. L. May and the writer, reached Port Stephens on October 4, 1923, and were joined by Messrs. Albert E. J. and H. W Thackway two days later, making our headquarters at Nelson Bay, which is about 90 miles N.W. by N. of Sydney and about 20 miles north of Newcastle. The reefs upon which the Polyplacophora were collected consist of weathered felspar porphyry.

Owing to the limited time at our disposal and the long length of coast which had to be examined, our attention was confined to the southern shore between Dutchman Bay and Tomaree (South) Head, and the open sea coast, from the latter head to Fingal Point, a distance in all of about 15 miles. The advance party had noted some rocky points west of Nelson Bay from the deck of the little steamer, and as far as the unfavourable tides would permit, spent the first two days in investigating the neighbourhood for promising spots. Several places were tried westward (further up the harbour), but the results were not very encouraging; this was probably due to the dirty character of the water.

On the arrival of the Messrs. Thackway, by dividing the party into two, the coastline to Tomaree Head was explored. The real work began on October 8, taking advantage of the spring tides which reached their maximum low point on the 10th idem.

As the Thackways were able to continue their stay for about a fortnight after those of us from the other States had left, they were able to extend the investigation to the open coast outside the heads, and to add very materially to the sum-total of the material collected. My heartiest thanks are due to Albert E. J. Thackway and W. L. May for the loan of material, and to the former for the use of his very copious notes on the material collected and the ground examined.

Reefs at each end of Nelson Bay were found to be moderately good; sixteen species being secured on the western reef, between the old wharf and Dutchman Bay, and eighteen species on the eastern. The western reef was remarkable for the large colonies of excellently preserved specimens of *Onithochiton quercinus,* as was the eastern for numbers of an exceptional colour variety of *Haploplax lentiginosus.* A cursory examination was made of the reef around Nelson Head,

with favourable results; time was too limited for as thorough an examination as is desirable. Further investigation will probably prove this point to be one of the richest in the harbour. The coast between the eastern end of Shoal Bay and Tomaree Head was most disappointing, although a whole day was occupied in prospecting it, nothing worthy of being noted was taken over a distance of approximately of one mile.

Along considerable strips of this coast, many of the stones examined were bare of apparent life, and in numerous instances large areas of seemingly good ground were found to be quite barren. The headlands at False Bay, on the open ocean, were even poorer than at Tomaree Head; the causes of the apparent paucity of life in these localities seem obscure and are worthy of careful investigation.

The most profitable ground was located at Fly Point and extended for nearly half a mile between Nelson Bay and Little Bay. Only a small portion of this fine ground was touched, but it was found extremely rich both in species and in examples, as the appended notes testify. Examples of every genus recorded from New South Wales, with the exception of *Choriplax*, *Liolophura*, and *Tonicia*, were taken within a distance of less than a quarter of a mile. The results of the united labours of our party were most gratifying, yielding, as they did, a wealth of specimens, including most of the recorded fauna in New South Wales; many individual specimens are of exceptional beauty. One new species of *Acanthochiton* is described and another member of the same genus is added to the fauna of the State; 28 species besides named varieties were secured. The entire absence of *Liolophura gaimardi*, Blainville, which is such a common species at Port Jackson, is remarkable.

All measurements quoted in this record are of dried specimens.

Family Lepidopleuridae, Pilsbry.

Lepidopleurus badius.

Lepidopleurus badius, Hedley and Hull, Rec. Austr. Mus., vii., 1909, p. 260

Specimens of this species were rare, half a dozen in all being taken, ranging from 3×1·5 mm. to 5×2·5 mm. The examples were mostly found on small stones embedded in shell-sand and in comparatively shallow water. One specimen was taken in a small rock pool near high-tide mark. A wide range of colour variation was shown, the series ranging from a brick-red to a light straw. This species was only found within a very limited area on Fly Point.

Family Callochitonidae, Thiele.

Callochiton platessa.

Chiton platessa, Gould, Proc. Bos. Soc. Nat. Hist., ii., 1864, p. 194.

Callochiton platessa, Gould, of Pilsbry, Man. Conch., xiv., p 49, pl. 10, figs. 1-5.

Fairly common at Fly Point and on the reef between Nelson and Dutchman Bays. A good series in all stages of growth, the largest specimen taken measured 28×17 mm. All typical specimens, the various shades of red and green assimilating with the colours of the encrusted rocks upon which they were found.

Callochiton platessa, Gould, var. fossa, Ashby.

(Trans. Roy. Soc. S. Austr., vol. xlvi., 1922, p. 19).

A few specimens of this pitted form were found.

Family ISCHNOCHITONIDAE, Pilsbry.

ISCHNOCHITON (LINEOLATUS) CRISPUS.

Chiton lineolatus, Blainville, Dict Sci. Nat., vol. xxxvi., p. 541.

Chiton crispus, Reeve, Icon., pl 19, f. 120, May, 1847.

Ischnochiton lineolatus crispus, Rv, of Ashby, Trans. Roy. Soc. S. Austr., vol. xliv., 1920, pp. 273, 274.

This sub-species, although by no means rare, was not as plentiful as might have been expected. The specimens taken were mostly comparatively small, but a very beautiful series of colour variations was obtained. The largest measures 30×14 mm. Examples were met with on all reefs between Dutchman Bay and Shoal Bay; none were seen at Tomaree Head, or on the coastal reefs. It is worthy of note that in the locality under review, *crispus* was principally obtained in fairly deep water.

ISCHNOCHITON PROTEUS

Chiton proteus, Reeve, Conch. Icon., iv., 1847, pl 8, f 11, *C. divergens*, Reeve, *l.c.*, pl. 18, f. 44.

This species and the following one, *fruticosus*, are the commonest chitons in the district. Numerous examples were found in every place explored and in every stage of growth. Some stones examined were literally covered with these. Very large and clean specimens were frequently taken and a remarkable series of colour variation embracing ground colours of greens, whites, reds, and browns, with varying patterns and colour markings, was observed.

ISCHNOCHITON FRUTICOSUS

Chiton fruticosus, Gould, Proc. Bos. Soc. Nat. Hist., ii., p. 142, 1846.

Equally numerous with the preceding species and found at all levels, from half tide to deep water. A few examples of a novel green variety, with burnt-umber dorsal region and brown girdle, were secured.

ISCHNOCHITON EXAMINANDUS.

Ischnochiton examinandus, Hull, Austr. Zool., vol. iii., pt. iv., 1923, p 160, pl xxv., f. 1-4.

Comparatively rare; about a dozen specimens in all were collected, the sizes varying from 7×4·5 mm. to 15×8 mm. Of these, three were similar in colouration to the type, the remainder show general schemes of green, orange, or brown. Slight differences in the shape occur, some being more elongate than the others.

ISCHNOCHITON (HAPLOPLAX) SMARAGDINUS.

Lophyrus smaragdinus, Angas, Proc. Zool. Soc., 1867, p. 115, pl 13, f. 28

Ischnochiton smaragdinus, Pilsbry, Proc. Ac Nat. Sci, Phil., 1894.

This species is very common at all places examined between Nelson Bay and Fly Point, inclusive, and was one of the few species found in the neighbourhood of Tomaree Head. The largest specimen taken was 23×13 mm., and the variation in colour scheme and pattern was very great.

Ischnochiton smaragdinus, Angas, var. picturatus, Pilsbry, Proc. Ac. Nat. Sci., Phil., 1894, p. 72.

Very numerous in the same localities as the typical form, but none were seen on the open coast; they were found both in deep water and in rock pools above low-tide mark.

ISCHNOCHITON SMARAGDINUS, var. FUNEREUS, n. var.

A very distinctive variety of *Haploplax smaragdinus*, in which the whole of the tegmentum is of a uniform black, without any colour relief, and the girdle is consistently of a yellow tint, varying in shade from light straw to golden-yellow, transversely banded at irregular distances, with narrow bands of a darker

tint, suggesting shadows. The sculpture and girdle scales are similar to typical shells.

As this variety is so distinct and exceptional in colour to any other New South Wales shell, it seems worthy of a distinctive name. I therefore suggest the name *funereus* for this variety. Besides the few examples taken at Port Stephens, both Thackway and Hatcher have taken it at Long Reef, and the former has taken it at Mereweather, Botany Bay, Bulli, and Port Jackson; the writer also found an example, 17 mm. in length, on the one occasion he has visited Vaucluse. The type measures 12×7 mm., is from Long Reef, and was given to me by Mr. W. H. Hatcher.

ISCHNOCHITON (HAPLOPLAX) LENTIGINOSUS.

Chiton lentiginosus, Sowerby, Mag. Nat. Hist., iv., 1840, p. 293.

Chiton lentiginosus, Reeve, Conch. Icon., iv., 1847, pl. 24, f. 165.

Ischnochiton lentiginosus, Pilsbry, Proc. Ac. Nat. Sci., Phil., 1894, p. 73.

Very common on all reefs. The specimens collected are of an unusual colour pattern for this species, and may probably be regarded as a local variety. Nearly all the examples are confined to different shades of brown. The Port Stephens form has an irregular, dark, dorsal stripe on all valves, which is margined on either side by a lighter band, the whole being maculated with the typical blue spots and lines. Examples from Bulli and Long Reef (near Manly) mostly have a monochrome ground, decorated with the usual blue marks.

ISCHNORADSIA AUSTRALIS.

Chiton australis, Sowerby, Mag. Nat. Hist., iv., 1840

Ischnochiton australis, Reeve, Conch. Icon., iv., 1847.

In numbers this species was second only to *proteus* and *fruticosus;* specimens were collected at all points, but in common with other species, were scarce around Tomaree Head.

Subfamily CALLISTOPLACINAE, Pilsbry.

CALLISTOCHITON ANTIQUUS.

Chiton antiquus, Reeve, Conch. Icon., iv., 1847, pl. 25, f. 169.

A long series was obtained at Fly Point and Nelson Head; these are all of the usual form and are nice clean examples. This chiton was quite difficult to locate owing to its colour and sculpture, assimilating, as it does, so well with the rocks upon which it is found.

Family MOPALIIDAE, Pilsbry.

PLAXIPHORA ALBIDA.

Chiton albidus, Blainville, Dict. Sci. Nat., vol. xxxvi., 1825, p. 547.

C. costatus, Blainville, *l.c.*, p. 548. Discussed by Iredale, Proc. Mal. Soc., ix., pt. ii., p. 96.

Plaxiphora albida, Blainville, of Ashby, Trans. Roy. Soc. S. Austr., vol. xlvi., 1922, pp. 575, 576.

Over a score of specimens were taken, but this species is not plentiful in the portions of the coast examined. The shells on the average are smaller than those found further south. All specimens collected were from levels between high and low-tide marks; none were seen below the latter, and all were covered with algae.

NOTE.—As I have stated in several of my earlier papers, it has been found that examples of members of this genus from Queensland, in the north, round the south coast of Australia, and up the west coast of Western Australia, as far as Dongarra, show so much variation both in shape and sculpture, with apparent

intermediates, that it has seemed best to make no attempt to define separate species, until a very large series was available from all parts of the Australian coastline.

The examples from Port Stephens form a very welcome addition to what is already a very representative collection. The writer's experience very closely coincides with the views expressed by Iredale in the paper above cited.

Family ACANTHOCHITIDAE, Pilsbry.

ACANTHOCHITON GRANOSTRIATUS.

Acanthochites granostriatus, Pilsbry, Naut., vii., p. 119, 1894.

Acanthochiton granostriatus, Pilsbry, of Ashby, Trans. Roy. Soc. S. Austr., vol. xliv., 1920, pp. 287, 288.

This species was not numerous, but a fair series was collected, mostly showing brighter colouration than specimens found in South Australia.

ACANTHOCHITON PILSBRYI, MAUGHANEANUS.

Acanthochiton pilsbryi, Sykes, Proc. Mal. Soc., Lond., vol ii., pt 2, 1896.

Acanthochiton maughani, Torr and Ashby, Trans. Roy. Soc. S. Austr., 1898, p. 12.

Acanthochiton pilsbryi maughaneanus, Ashby, Trans. Roy. Soc. S. Austr., vol. xliii., 1919.

A few very fine specimens were obtained measuring up to 12×4·5 mm. On the way to Port Stephens some of our party broke their journey at Point Clare, on Brisbane Water, and there found three examples of this shell in which the granules were more irregular in shape than is normal.

ACANTHOCHITON VARIABILIS.

Hanleya variabilis, Adams and Angas, P.Z.S, 1864, p. 194.

Acanthochites variabilis, Adams and Angas, of Pilsbry, Proc. Ac. Nat. Sci., Phil., 1894, p. 184.

This widely distributed species was by no means common at Port Stephens; one or two of the specimens collected show the bright blue colouration which seems to be a feature of those collected by Hatcher at Long Reef, near Manly.

ACANTHOCHITON KIMBERI.

Acanthochites kimberi, Torr, Trans. Roy. Soc. S. Austr., vol. xxxvi., 1912.

This shell has not previously been recorded from the State of New South Wales, and it was an unexpected pleasure to meet with it so far from the type locality in South Australia. Several very fine specimens were secured, the largest measuring 18×6 mm.; the previously known largest specimen is one collected by Mawle, in Port Arthur, in Tasmania, that measures 16·5×7·5 mm.

As it is not difficult to confuse this shell with the variety of *Acanthochiton retrojectus*, named by the writer *pustulosus*, Ashby, the following comparison should be helpful. In *pustulosus*, the girdle fringe is often not visible, but in larger specimens, when present, the fringe is shorter and spicules more slender than in *kimberi*. In the sculpture, the large granules of *pustulosus* are always strongly convex and strongly elevated, in *kimberi* the larger granules are flat though very irregular in size, often very elongate. Under a magnification of 65, the minute grains clothing the girdle of *retrojectus* and its variety *pustulosus* are larger than those in *kimberi*, and seem to coalesce in irregular masses; whereas in *kimberi*, in addition to the grains being more minute, they lie more smoothly and are so arranged in groups, that collectively they form shallow rings with a hole or crater in the centre.

A very beautiful variety was secured by Thackway, in which the first two valves are white; valves 3, 4, and 5, red; valves 6 and 7, white with red dorsal area; and tail valve dark.

ACANTHOCHITON RETROJECTUS.

Acanthochites retrojectus, Pilsbry, Naut., vii., p. 107, 1894.

This little species was not common, but specimens were taken up to 14×5·5 mm.

ACANTHOCHITON RETROJECTUS, var. PUSTULOSUS.

Acanthochiton retrojectus, var. *pustulosus*, Ashby, Trans Roy. Soc. S. Austr., vol xlvi., 1922, pp. 15, 16.

Several examples of this striking variety of *retrojectus* were met with; in some the large granules are developed at a very juvenile stage, in others the sculpture is quite typical of *retrojectus* until the shell is more than half grown, when the very coarse, highly elevated grains are produced.

Acanthochiton thackwayi, n. sp.

Pl. xxxi., figs. 1, 2.

General Appearance.—Broad, girdle almost entirely covered by the long extruded spicules, a dense rather long girdle fringe, shell highly arched and rounded, side slope curved, median valves beaked.

Colour.—Pale creamy-brown, dorsal area of valve 2 rose pink, spicules similar in colour to the valves.

Anterior Valve.—This valve is unusually elevated, slope curved and steep, 5 ray ribs or undulations, the two lateral ones being shallow, the three in the centre ones strongly elevated, closer together and with deep troughs between them. The ribs are decorated with two rows of closely packed, small, rounded, cream-coloured granules.

Posterior Valve.—Small, mucro not raised, median or postmedian, posterior slope steep, covered with closely packed, cream-coloured granules. Dorsal area pinnatifid and in proportion to the size of this valve, broad, dark coloured; the pleural area of this valve is decorated with small closely packed granules, placed in longitudinal rows.

Median Valves.—Broad, elevated, arched, side slope curved, posterior margin strongly beaked, the shell bending outwards again towards the girdle, quite as far, if not further, than the beak. The dorsal area is broadly wedge-shape, the beak is a little rugose, but this may be due to slight erosion; under a pocket lens, only the posterior half of this area is smooth, and from there, anteriorly, the area appears strongly grooved, but under a Zeiss binocular, mag. 65 times, this apparent grooving is found to be only simulated by an alternation of dark, subcutaneous, longitudinal lining with white opal-like lining, so that, except for transverse growth lines, this area is smooth. This area is strongly pinnatifid, four of the lateral "teeth or pinnae," which are cream-white, can be counted on each side of the dorsal area; from each of their apices commences a more or less longitudinal row of small closely packed granules; the pleural and lateral areas are not separable, both being similarly sculptured with bowed, more or less longitudinal, rows of minute, bead-like, closely packed granules; these granules are so closely packed in the rows that, under a pocket lens, they appear everywhere touching, and the rows are so close to one another that there is no well-defined suture between them. The grains towards the outer margin are but little larger than those nearer the dorsal area. Under a binocular with 65 magnifications the granules are less bead-like, are not hemispheres, as they appear under a high-power pocket lens, but are strongly raised, circular, convex granules, the curvature being flatter in some than others; also, they rarely imbricate, although so close together, and are usually separated.

The interspaces between the grains, although the shell has been boiled for some time, still seem partially filled with the most minute grains of sand.

Girdle.—Is furnished at the sutures with hair tufts of exceptionally long, slender, glassy spicules, and under mag. 65 times, shorter, extremely slender spines are interspersed amongst them. The girdle fringe is very dense, seemingly composed of three rows of spicules; the rest of the girdle is covered with coalesced, minute grains.

Measurements.—The type is 9×4·5 mm., including the hair tufts; shell itself only 7×4·5 mm. Thackway's specimen 9·5×5 mm.

Habitat.—In addition to the type, which was collected by the writer at Fly Point, a second specimen was taken by Mr. Albert E. J. Thackway at the same spot.

In conclusion.—This species is distinguished from *bednalli* by the dorsal area being pinnatifid and smooth, although simulating grooving by subcutaneous lining, and by the granules being circular and convex, whereas in *bednalli* they are longer and flat-topped. The same characters still more widely differentiate it from *granostriatus*.

ACANTHOCHITON (NOTOPLAX) COSTATUS

Acanthochites costatus, Adams and Angas, P Z S., 1864, p 194

Macandrellus costatus, Dall., Proc. U S Nat. Mus., i., p. 81.

Notoplax costatus, Adams and Angas, of Ashby, Trans Roy. Soc S Austr., vol. xliv., 1920.

Three specimens of this shell were taken; the largest 19 mm long, girdle evenly but not densely covered with short spicules The ribs on valves in the smallest specimen are considerably less raised than those of the other two. In Tasmania all the examples seen from Port Arthur have shallow ribs, whereas those taken in the D'Entrecasteaux Channel all have coarse ribs.

Family CRYPTOPLACIDAE, Dall.

CRYPTOPLAX ROSTRATUS.

Chitonellus rostratus, Reeve, Conch. Icon., f 6, 1847

Cryptoplax torresianus, Rochebrune, Bull. Soc Philom., Paris, 1881-1892, p. 195

Cryptoplax rostratus, Rv., of Ashby, Trans Roy. Soc. S. Austr, vol. xlvii, 1923.

This chiton was very numerous, several specimens being taken up to 63 mm. in length (dried specimens); in life they would have measured considerably more. While the girdles of most were densely clad with normal, brown spicules, a few had orange-brown spicules, making them very conspicuous in the water, also, in a few examples, the dorsal area in each valve is porcelain-white, the rest of the valves brown; in these the dorsal area, especially at the beak, is touched up with pink.

In my discussion of this species in the paper cited above occur these words: "Also the valves *C. rostratus*, even in the fully adult shell, still touch one another." Having now examined the large number of specimens taken at Port Stephens, I find I have to qualify this statement, for in the very large specimens, after valve 4, the valves are distinctly spaced; but this feature, which is normal in *C. striatus*, Lamarck, does not seem to occur in *rostratus* until reaching extreme senility. The granular character of the sculpture is retained even in the largest specimens, but the granules are less bead-like and more elongate than is the case in younger examples.

Family CHITONIDAE, Pilsbry.

RHYSSOPLAX JUGOSUS.

Chiton jugosus, Gould, Proc. Bos. Soc. Nat. Hist., ii., p. 142, 1864.

Rhyssoplax jugosus, Thiele, das Gebiss der Schnecken, vol. ii., p. 368.

A very fine series with wide variation in the colour pattern was taken.

RHYSSOPLAX COXI.

Chiton coxi, Pilsbry, Proc. Ac. Nat. Sci., Phil., 1894, p. 85.

A fair number were secured; most of them were more or less normal, olivaceous, flecked with cream and pink markings. In one remarkable specimen, measuring 15×9 mm., all the valves, other than valve 2, are brilliant, absinthe-green, with a bright pink spot at the apex of the anterior valve and at the beak of the other valves; valve 2 is ox-blood-red, and the whole of the girdle is broadly and irregularly banded in these colours, with the addition of cream-white and three or four narrow, very dark, reddish bands. Altogether, it is perhaps the most brilliantly coloured chiton I have ever seen. (Ridgway's Colour Standards, pls. xxvi. and i.)

RHYSSOPLAX CARNOSUS.

Chiton carnosus (Carp. MSS.), Angas, P.Z.S., 1867, p. 222.

Rhyssoplax jacksoniensis, Ashby, non *Chiton limans*, of Sykes, Proc. Roy. Soc. Vict., 33 (n.s.), 1921.

Rhyssoplax carnosus, Angas, of Hull, Austr. Zool., vol. iii., pt. iv., 1923.

Amongst the series collected were some of the most brilliantly coloured forms yet obtained, ranging from normal, mottled olivaceous, through cream, with three or four dark, almost black, valves to pink, brick-red, and orange.

RHYSSOPLAX VAUCLUSENSIS.

Chiton vauclusensis, Hedley and Hull, Rec. Austr. Mus., 1909, p. 261, pl. lxxiv., figs. 19-23.

Several examples of this fine and rare chiton were collected, Port Stephens being an entirely new locality. I am also glad to be able to record that my correspondent, William H. Hatcher, has also been successful in finding it at Long Reef, near Manly. Thus, although still a rare shell, its habitat is slowly yet surely being extended.

RHYSSOPLAX TRANSLUCENS.

Chiton translucens, Hedley and Hull, *l.c.*

A good series of exceptionally fine specimens of this beautiful chiton was obtained measuring up to 41×21 mm. Most of them are coloured with soft shades of flesh-pink, variously blotched with olive; only one or two were of the green shade, with cream markings, mentioned in the description of the type.

SYPHAROCHITON PELLIS-SERPENTIS.

Chiton pellis-serpentis, Quoy and Gaimard, Zool. Astrolabe, iii., 1835, p. 381, pl. 74, figs. 17-22.

Sypharochiton pellis-serpentis, Q. and G., of Thiele, *l.c.*, p. 365.

In addition to our general research, two whole days were entirely devoted by the Messrs. Thackway in an endeavour to locate this species, and their labours were finally rewarded, when Mr. H. W. Thackway found a single specimen, near low water-mark, on the reef at the eastern end of Nelson Bay. This was almost the last chiton obtained during the visit. The search extended over the whole of the suitable ground between Dutchman Bay, in Port Stephens, and Fingal Point, on the open coast, covering a distance, in all, approximately, of 15 miles. With the exception of this single specimen, which Mr. Thackway has generously presented to the writer, no other example of this species, or of its associate in New South Wales waters, *Liolophura gaimardi*, Blainville, was met with; the specimen taken is typical of the form found at Port Jackson with the strong longitudinal ribbing; in southern Tasmania such strongly sculptured forms are far less common than the smoother ones.

Some additional notes on this chiton seem worth while. This species, in both New South Wales and Tasmania, is found from half-tide almost to high

water-mark, and is common throughout the southern coasts of the former State; and on the north, east, and southern coasts of the latter State Eroded specimens exposed to sun and air below high tide-mark may be found in large colonies within the areas named, in both States, but well-preserved specimens are moderately rare.

Thackway, May, and the writer have each been able to take a fair series of perfect specimens in their respective localities, from the underneath of large boulders, or in fissures, or caverns, into which the sun never penetrates, *i.e.*, places which, although above low water, are constantly damp or moist, and comparatively dark

North of Sydney, *pellis-serpentis* seems to become rarer At Mereweather, about four miles south of Newcastle, during October, 1923, Thackway made a search for this species along two miles of coast, when only three specimens were found. At Point Clare, on Brisbane water, north of the Hawkesbury, the writer took several specimens in a fair state of preservation, but it was not common there. In face of these evidences and the fact, that with all our searching, Port Stephens only yielded us one specimen, it seems probable that the Port is the northern limit of its range. Messrs. Iredale and May distinguished the Tasmanian forms of this shell, under the designation of *Maugeanus,* while I think the better way would be to consider them mere varieties of the New Zealand shell, if students prefer to consider the Tasmanian shell a geographic race, I suggest that the somewhat more highly sculptured form, found in New South Wales, be distinguished by the subspecific name of *septentriones*, a name suggested by the more northern habitat.

Subfamily Liolophurinae, Pilsbry

Lorica volvox.

Chiton volvox, Reeve, Conch. Icon, pl 6, f. 31, 1847

This species was not common, less than a score of specimens being found, the largest measuring 60 mm. in length; they were typical of Port Jackson shells.

Loricella torri.

Loricella torri, Ashby, Trans. Roy. Soc. S Austr, vol xlii, 1919

A long series was collected ranging from quite juveniles up to 52×36 mm Shades of green and pink are quite common in the girdles, the lateral areas and anterior valves, in some, show strong granules, in others the shell is almost smooth. The girdle, in some, was thickly clothed with branching spicules or setae, in others this feature was much less in evidence. In none of the fine series examined was there any evidence of the "spear-headed spicules" discovered by the writer, and which are so striking a feature of the South Australian shell *Loricella angasi*, Adams and Angas.

Onithochiton quercinus.

Chiton quercinus, Gould, Proc. Bos. Soc. Nat. Hist., ii, p. 142.

A fair series of this Onithochiton was secured, some showing very beautiful colour markings.

Note.—I have followed Pilsbry in the foregoing order, but note that Thiele places the two genera, *Lorica* and *Loricella*, under the Family Ischnochitonidae, and the Genus *Onithochiton* under the Subfamily Acanthopleurinae, as a group under the Family Chitonidae.

Also, I would add the following record, which, although it has nothing to do with the fauna of Port Stephens, it is, nevertheless, an interesting record

belonging to the same State, and will be of interest to other workers. The only occasion upon which it has been possible for the writer to visit that famous collecting ground for chitons, the Bottle and Glass Rocks, at Vaucluse, was on September 25, 1923, and was rewarded by two good finds. One was a very fine specimen of *Acanthochiton kimberi*, Torr, measuring, when dry, 14×6·5 mm., but when alive nearly double the width, owing to the extension of the girdle, a feature that is little seen in the small specimens from South Australia. This was an altogether new find for the State of New South Wales. On another broken shell was another great find, a very fine specimen of *Lepidopleurus* which had never before been seen by the writer, but was immediately recognised as being Hull's new *L. puppis*, which up to the present is only represented by a very few examples. This specimen measures 13·5×6 mm. and is in perfect order.

DESCRIPTION OF PLATE XXXI.

(For description see page 327.)

FURTHER NOTES ON AUSTRALIAN POLYPLACOPHORA WITH DESCRIPTIONS OF THREE NEW SPECIES.

By Edwin Ashby, F.L.S., M.B.O.U.

[Read October 9, 1924.]

Plate XXXI. (in part).

Family Ischnochitonidae, Dall.

Subfamily Ischnochitoninae, Pilsbry

Genus Ischnochiton, Gray.

Ischnochiton tindalei, n. sp.

Pl. xxxi., figs. 4*a*, 4*b*, 4*c*.

I am indebted to Sir Joseph Verco, Hon. Curator of Mollusca of the South Australian Museum, for the opportunity of describing this new *Ischnochiton*, which was collected by Mr. N. B. Tindale, of the same Museum, after whom I have pleasure in naming it. It was obtained at Groote Eylandt, in the Gulf of Carpentaria.

General Appearance.—Shell broad, valves arched but showing a slight angle at jugum, side-slope curved. Colour, Vinaceous Brown (Ridgway, pl. xl.).

Anterior Valve.—Is evenly and closely covered with spaced, circular, convex grains, which are exceptionally even in size, although a little smaller near the apex and a little larger near the margin; the interspaces are a little darker than the granules themselves; four broad, shallow, concentric growth-ridges are present in the type.

Median Valve.—Is arched, slight angle at jugum, dorsal area ill-defined, the arrangement of the granules and grain markings is longitudinal near the jugum, the granules are raised and circular, commencing small near the jugum and increasing to double the size and elevation in the pleural area; the lateral area is much raised, clearly defined, and equalling in size the pleural area; the granules are still circular but rapidly increase in size, both posteriorly and laterally; they are arranged in even, bowed rows both longitudinally and diagonally, forming a decussated pattern; the granules on the posterior margin are large and give a toothed appearance.

Posterior Valve.—This valve is large, mucro median, well defined, slope behind, for one-third, steep; other two-thirds, flatter. A strongly raised diagonal fold separates the posterior portion of the valve from the anterior; the posterior portion is similarly decussated, although a little less coarsely, to the lateral areas in the median valves, the anterior portion is similar in sculpture to the dorsal and pleural areas of those valves.

Articulamentum.—Is white, inside glassy white, anterior valve slits 9, fairly evenly spaced, teeth sharp; tail valve 8 slits, sutural laminae small, sinus between very wide. Median valves, slits 1/1, eaves well defined, insertion protruding slightly beyond the tegmentum, teeth sharp, sutural laminae small, sinus between very wide, tegmentum bowed outwardly in centre.

Measurements.—The shell was too crushed to allow of any accurate total measurement being given, but the two end valves and valve 2 are unbroken. The total of crushed shell is 8×5 mm. Anterior valve is longitudinally 1·5 mm., laterally 3 mm. Posterior valve is longitudinally 2·5 mm., laterally 3·5 mm. Median valve is longitudinally 1·5 mm., laterally 3·5 mm.

Girdle.—Densely clothed with minute, flat, imbricating scales.

Habitat.—Groote Eylandt, Gulf of Carpentaria, Northern Territory, living on a block of dead coral. Museum, No. D4656, one example.

Comparisons.—It differs from *I. luticolens*, Hull, in the very raised character of the lateral area, the slope from the pleural area to the lateral not being gradual, as in that species, but most abrupt. The shell is more elevated and the side-slope more curved, sculpture everywhere coarser, mucro central not anterior and posterior slope fairly steep, not concave, also *luticolens* has 50 per cent. more slits in the insertion of the end valves. It was at first my intention to describe this shell as a subspecies of *luticolens*, but the differences noted above, of form, sculpture, and slitting, seem to warrant its being given full specific rank, but it may be considered near to that shell.

Family CRYPTOCONCHIDAE, Iredale.

Subfamily CRYPTOCONCHINAE, Ashby.

Genus ACANTHOCHITON, Gray, em.

Acanthochiton macrocystialis, n. sp.

Pl. xxxi., figs. 3, 3*a*, 3*b*, 3*c*.

Introduction.—I am much indebted to Mr. W. L. May, of Tasmania, for placing in my hands for definition several examples of a new *Acanthochiton*. They are especially interesting from the fact that they have, as their host, the long ribbon-like alga, *Macrocystis pyrifera*, var. *dubenii*; my thanks are also due to Mr. L. Rodway for kindly identifying the plant. The specimens were sent to Mr. May by Mr. E. W. Mawle with the following note:—"These Acanthochitons I collected at the outside of Port Puer; their host is the long ribbon-like kelp, that grows near the bull kelp. The Acanthos live near the roots. I had to cut the roots open to find them; it is like basket-work where they live."

I was able to show in my paper on the genus *Stenochiton* (Trans. Roy. Soc. S. Austr., vol. xlii., 1918, pp. 65-78) that members of that genus of Chitons do not live on rocks but on "sea grasses." In another paper (*l.c.*, vol. xlv., 1921, pp. 136-142) on the "Re-discovery of *Choriplax*" one was able to adduce data which suggests that members of that most remarkable genus live on the stems of *Laminaria*. The present discovery is of exceptional interest, because it seems to establish the fact that there are other races of Chitons that occupy a very similar ecological niche.

General Appearance.—In the dried specimen the girdle occupies two-fifths of the total width, shell elliptical, colour Hellebore Green to Elm Green (Ridgway, pl. xvii.), mottled with white, outer border dirty white, dorsal area of valves 2 and 8 dark. Shell is arched, thickly decorated with small granules, hair tufts conspicuous, girdle thickly beset with spicules.

Anterior Valve.—The central portion of this valve consists of a V-shaped elevation, corresponding with the three central ray ribs; the actual ribs can only be distinguished in the juvenile portion of shell near the apex. The two lateral ribs are modified into mere waves; the whole valve is decorated with irregularly arranged, small, elongate, flat granules, which are anteriorly rounded or subacute, laterally straight-sided, the granules are raised anteriorly and shallow posteriorly. Articulamentum white, slits 4, well defined and suture or sinus carried to the tegmentum, the three central slits correspond with the three central ribs and the fourth slit with the fold on the right, but the lefthand slit is obsolete.

In another juvenile specimen the anterior valve also has only 4 slits, the lefthand one being absent.

Posterior Valve.—Tegmentum small, mucro postmedian, slope steep immediately behind the mucro; the dorsal area broadly wedge-shape, rugulose transversely and subgranulose near mucro, longitudinal grooving absent, sculpture of rest of valve similar to that of the anterior valve. Articulamentum white, much produced laterally, slits 3 well defined and sinus deep, sutural laminae shallow, sinus between broad. A second juvenile specimen has three slits in the tail valve similarly spaced.

Median Valve.—The following is a description of valve 2. The dorsal area is raised, arched and beaked, without longitudinal grooving but showing a little subcutaneous lining, numerously, transversely ridged, pitted near beak. The lateral and pleural areas are similar in sculpture, there is a slight diagonal fold, the granules are similar in shape to those of the anterior valve, except that they are longer and more definitely subacute, the sides of some of the granules not being parallel but converging. The granules adjoining the dorsal area are very elongated and coalesce. The general arrangement of the rows of granules is longitudinal, parallel with the outer margin of the tegmentum. Articulamentum white, sutural laminae well produced forward, sinus between wide, insertion plate in this particular valve unslit, but in a juvenile specimen that has been disarticulated some of the median valves have slits 1/1, notches very short and inconspicuous but sinus carried to the tegmentum.

Girdle.—Hair tufts are large and composed of massed, slender spines; girdle is closely beset with coarser spicules.

Habitat.—Living on the roots of the alga *Macrocystis pyrifera*, off Point Puer, near Port Arthur, Tasmania.

Measurements.—Total of type 15·5×8 mm., largest specimen 20×9 mm., second largest 17×8 mm. Anterior valve longitudinally 2·75 mm., laterally 3·5 mm. Posterior valve longitudinally 2 mm., laterally 3·5 mm. Median valve longitudinally 3·5 mm., laterally 4 mm.

Comparisons.—*A. granostriatus* has narrower dorsal area, granules much more elongate and very shallow, the granules connected with one another radially by a slight raising of the floor, giving a streaky appearance under lateral lighting.

A. bednalli has also a narrower dorsal area, which is deeply, longitudinally grooved; in *bednalli* the granules are shorter and bluntly obovate, with flat to concave surfaces, the granules in *macrocystialis* are equally raised, but are longer, differently shaped, and often pointed. In the type of *gatliffi*, the dorsal area is more granulose and is longitudinally rugose, very distinct from the species under discussion, the sculpture of the other areas of *gatliffi* is more widely spaced and regular, the granules are attached at their bases, the anterior portion standing away from the shell, the granules themselves are shorter and broader, and the girdle in *gatliffi* is spongy, whereas in this species it is very spiculose.

Paratypes of A. macrocystialis, Ashby.—(a) Is greenish-buff, sculpture similar but the dorsal area is subcutaneously lined with white wavy lines, measures 9×4 mm. (b) Is buffish-brown, the dorsal area is marked with dotted lines and the shallow pitting is a little more marked, both this and the preceding show less of the spiculose character of the girdle than the larger specimens, this may be due to the breaking of the spicules, hair tufts are similar. (c) Two examples measuring, respectively, 10×5 and 8×4 mm., taken "off kelp" at the same locality, are both buff and granules white, the white dotted lining in the dorsal area is very marked, the sculpture is similar to type, the spiculose character of the girdle is conspicuous in the larger of the two.

Craspedochiton jaubertensis, n. sp.

Pl. xxxi., figs. 5*a*, 5*b*, 5*c*.

I am indebted to M. Nils H. J. Odhner, of Stockholm, for the example described hereunder. It was sent to me under the name *Craspedochiton laqueatus*, Sowerby, from which it seems distinct. It had been dredged off Cape Jaubert by Dr. E. Mjoberg, leader of the Swedish Scientific Expeditions of 1910-1913.

General Appearance.—The specimen is much curled and preserved in spirit; the girdle is very wide, occupying two-thirds of the width of the shell, and is ochreous-brown and non-spiculose and without hair tufts; the dorsal area is much raised and the diagonal rib very prominent.

Anterior Valve.—The whole of the upper portion of shell eroded, 5 radial folds or ribs corresponding with the slits, decorated with small, closely packed (usually separated), raised, squarish granules; towards the anterior margin the arrangement appears to be more or less concentric.

Posterior Valve.—Mucro raised and anterior, dorsal area broadly wedge-shape, smooth with a deep groove on either side, a raised diagonal fold from mucro laterally, posterior slope flat, tegmentum decorated with similar granules to the anterior valve, except that they are rather more convex.

Median Valve.—Dorsal area beaked, wedge-shape, the narrow central portion being divided from the elevated margin by a deep groove on either side, the outer ridges of this area slope steeply to the pleural area, giving to the whole dorsal area a highly raised appearance. The pleural area is separated from the lateral area by a narrow, highly raised, diagonal rib, which corresponds with the slit. The pleural area is decorated with longitudinal rows (I count 10) of spaced, raised, square to elongate, small, evenly distributed granules. The lateral area is similarly decorated, but the arrangement here is confused and the granules are larger.

Inside.—White, anterior valve 5 slits opposite the 5 radial ribs, teeth coarsely and irregularly dentate, propped on both sides. Posterior valve, insertion plate short, very coarsely dentate and propped, the number of slits difficult to determine, probably 8, sutural laminae well produced, sinus broad, anterior margin fairly straight. Median valve. Particulars are of No. 2 valve, insertion plate broad, eaves ill-defined, slits 1/1, festooned on either side as in genus *Callistochiton*, sutural laminae well produced, anterior margin straight, sinus broad, tegmentum bowed outwardly in centre.

Body.—The foot is very small, in curled specimen 7 mm. long, between the foot and the inside of girdle proper is a protruding spongy mass, on the outer side of which are numerous scales.

Measurements.—Example preserved in spirit total length 36 mm. by 22 mm., the anterior portion of the girdle measures 5 mm., and the posterior portion behind the tail valve 2 mm., of the total width of 22 mm., the shell measures only 7·5 mm., the rest being girdle. Median valve laterally 9 mm., longitudinally 6 mm. Posterior valve laterally 6 mm., longitudinally 4 mm. Anterior valve is incomplete but must have been fully 8 mm., laterally.

Girdle.—Colour ochreous-brown, very broad, occupying two-thirds of the total width, is asymmetrical, being broader in front than behind, encroaches on the valves at the sutures, is non-spiculose but covered with very minute corneous bodies.

Habitat.—Dredged in 70 feet off Cape Jaubert, 42 miles W.S.W., north-western Australia, by Dr. E. Mjoberg, 26th May, 1911.

In conclusion.—While in the British Museum in June, 1922, I compared this specimen with the type of *Craspedochiton laqueatus*, Sowerby. This latter was

from the Philippines; the species under review differs from it in the shape of the granules, which in *jaubertensis* are small and many elongate and narrow, whereas in *laqueatus* they are large, flat, and squamose; in *jaubertensis* the girdle is broader and encroaches more on the valves at the sutures. While certainly allied to *laqueatus*, we noted at the time that it certainly was a distinct species.

Corrections to Paper on Examination of Types in Paris.

Dr. Ed. Lamy, in Bull. Mus. Nat. Paris, 1923, pp. 260-265, points out that in the published results of Ashby's examination of the collections of Polyplacophora in the Paris Museum (Trans. Roy. Soc. S. Austr., xlvi., pp. 572-582), "some errors have crept in in the deciphering of the labels, with their faulty and illegible notes."

As pointed out in my introduction to that paper, owing to the limited time available, there was no opportunity of checking or correcting the records of observations, with the added difficulty, that both Dr. Lamy and the writer were unfamiliar with each other's language, it was impossible to avoid all mistakes. I am much indebted to Dr. Lamy for the following corrections:—

Page 578, in place of "Voy. de l'Astrolabe," read "Animaux sans Vertebres, 2nd Edition, Deshayes, vol. vii., p. 520."

Page 574, 13 lines from bottom, read "Dufresne M.S.S. in place of Dufrizai."

Page 581, Specimen (e), for "in spirit" read "dry."

DESCRIPTION OF PLATE XXXI.

(Reproduced from photographs by E Ashby.)

Fig. 1. *Acanthochiton thackwayi*, Ashby. Type from Port Stephens
" 2. " " " Paratype from Port Stephens.
" 3. " *macrocystialis*, Ashby. Type from Point Puer.
" 3*a*. " " " Type, anterior valve.
" 3*b*. " " " Type, median valve.
" 3*c*. " " " Type, tail valve (showing three slits in the insertion).
" 4*a*. *Ischnochiton tindalei*, Ashby. Type, anterior valve, from Groote Eylandt
" 4*b*. " " " Type, median valve, from Groote Eylandt.
" 4*c*. " " " Type, tail valve, from Groote Eylandt.
" 5*a*. *Craspedochiton jaubertensis*, Ashby. Type, anterior valve (showing dentate and propped insertion), N.W. Australia.
" 5*b*. " " " Type, median valve, N.W Australia.
" 5*c*. " " " Type, tail valve, N.W. Australia.

NOTES ON THE TYPES OF AUSTRALASIAN POLYPLACOPHORA IN THE BRITISH MUSEUM.

By Edwin Ashby, F.L.S., M.B.O.U.

[Read October 9, 1924.]

In June, 1922, I had the opportunity of examining the types in the collections, in the British Museum, and my thanks are due to the authorities of that Museum for granting me facilities for this examination, to the staff and Mr. Tom Iredale for much assistance.

I had intended publishing these notes in connection with the proposed monograph on Australian Polyplacophora I had been working on for some years, but now Messrs. Iredale and Hull have commenced a similar work, it seems best to publish these notes without further delay. The types were compared with examples in the writer's collection.

Stenochiton juloides, Ad. and Ang. Type, from Gulf St. Vincent, South Australia. This is a typical specimen of South Australian shells of *Stenochiton (Chiton) longicymba*, Blainville.

Ischnochiton virgatus, Reeve. Type, from Port Lincoln, is similar to examples from the same locality in the writer's collection.

Ischnochiton (Chiton) decussatus, Reeve. Type, from Australia. This is the shell we used to know under this name in South Australia, but now know under the name *I. contractus*, Reeve. This latter was described by Reeve as having solitary granules in the lateral areas (sic disjunct); this character is so distinctive that one is compelled to concur with Iredale in considering Reeve's two species, *contractus* and *decussatus*, as conspecific, *contractus* having page precedence.

Ischnochiton castus (Cpr. MS.), published by Pilsbry. Type, from Swan River. This is the shell we know as *Ischnochiton contractus*, Reeve. The slight bridging in the pleural area does not commence at quite so early a stage as is the case in specimens from South Australia; the sculpture of the pleural area appears stronger.

Ischnochiton (Lepidopleurus) speciosus, Ad. and Ang. Type. This is the shell we know as *I. contractus*, Reeve.

Ischnochiton (Chiton) proteus, Reeve. Type, from Newcastle, New South Wales, collected by Dr. Dieffenbach. This is the shell we used to know under the name of *I. divergens*, Reeve, from Port Jackson.

Ischnochiton (Chiton) ustulatus, Reeve. Type. This is not an Australian species; in shape and sculpture it seems similar to the New Zealand species known as *Ischnochiton maorianus*, Iredale. The girdle scales are like that shell though a little less irregular than are the scales of examples from Doubtless Bay, with which I compared them. I consider that *Chiton ustulatus*, Reeve, is a rufous variety of the New Zealand *Ischnochiton maorianus*, Iredale.

Ischnochiton variegatus, Ad. and Ang. The type of this shell is not in the collections and seems to have been lost. The specimens sent by Bednall to the British Museum, under that name, include *I. lincolnensis*, Ashby, as well as other species.

Ischnochiton (Chiton) arbutum, Reeve. Type, from Port Essington, October, 1844. These agree with examples in my collection from North Queensland.

Ischnochiton crispus, Reeve. Type, collected by Dr. Dieffenbach at Newcastle, New South Wales. They are a subspecies of the shell from King Island which was described by Blainville under the name of *Chiton lineolatus;* of the nine examples, 1 is pink, 4 cream, and 4 yellowish-green, and correspond with specimens in my own collection from Port Jackson.

Ischnochiton (Chiton) carinulatus, Reeve. Type marked from Van Diemen's Land. It is not conspecific with any of the following *Ischnochitons: ptychius, tateanus*, or *falcatus*. Iredale considered it a South American shell.

Ischnochiton (Heterozona) cariosus (C pr. MS.), Pilsbry. I saw the example that is believed to be the type; it is whitish, rather worn, and similar to South Australian specimens known under this name from Gulf St. Vincent, which I designate as the locality of the type.

ISCHNOCHITON PALLIDUS, Reeve, 1847.

Chiton pallidus, Reeve, Conch. Icon., t. 16, f. 92, March 1847. Non *Chiton contractus*, Reeve = *I. lineolatus*, Bl. of Iredale = *I. contractus*, Rv. of Sykes, Bednall, Torr, and others = *I. iredalei*, Dupuis = *I. iredalei*, Dupuis, of Ashby, Ashby and Hull and May = *I. lineolatus*, Bl. of Iredale and Hull. Sykes, Bednall, and Torr each followed Pilsbry in using the name *contractus*, Reeve, for this shell, and each of them considered *Chiton pallidus*, Reeve, to be a synonym. The recognising by Iredale that *contractus* and *decussatus*, both of Reeve, were conspecific, led Dupuis to give the name of *iredalei* to this shell, overlooking the earlier name of *pallidus*, Reeve.

Reeve's type is a very worn specimen of the shell described by Dupuis under the name *iredalei*, from a specimen given to him by myself from Gulf St. Vincent, in South Australia, which is therefore the type locality, not Flinders Island, as designated by Iredale and Hull. As no locality is given for Reeve's type, I designate Gulf St. Vincent as the type locality.

Iredale and Hull, in the Aust. Zool., vol. 3, pt. 6, pp. 232, 233, again discuss this shell under the name of *I. lineolatus*, Blainville. The position taken up first by Iredale, and now by Iredale and Hull, is in opposition to the opinions expressed by Dupuis, Dr. Lamy, and myself, each of whom has carefully examined the collections in Paris, and Iredale and Hull's attitude is quite unsupported by facts.

When I was in Paris in July, 1922, Dr. Lamy was good enough to assemble for me the whole of their collections of Polyplacophora, and, further, we assembled into one block the whole of the Australasian material, both dry and spirit-preserved specimens.

(1) In the whole of these collections I did not see a single specimen of the *I. pallidus,* Reeve, syn. *I. iredalei*, Dupuis, which is the shell Iredale and Hull would have us consider to be *lineolatus*, Blainville.

(2) Blainville distinctly states that his type of *lineolatus* came from "Ile King" and was collected by Peron and Lesueur.

(3) There are several examples of the shell we know as the southern form of *I. crispus,* Reeve, on the tablets marked as from "Ile King," collected by Peron and Lesueur.

(4) The specimen mounted on one of these tablets, which has been recognised by Dupuis, Lamy, and the writer as Blainville's type of *lineolatus*, is one of these examples and exactly agrees with Blainville's description, both in colour, sculpture, and markings, the numerous striae mentioned being most apparent on this specimen.

(5) M. Dupuis gave me four examples that had been collected on King Island by Peron and Lesueur; three of them are the southern form of *crispus,* Reeve, the other is *Ischnochiton (Heterozona) subviridis,* Iredale and May;

also in faded ink on the inside of the shell of one of the former are the words "Ile King."

The position taken by Iredale and Hull appears to me quite untenable; they would have us recognise as Blainville's type of *lineolatus*, which Blainville states came from King Island, a species which is unrepresented in the Paris collections Further, they would have us consider that the shells, which Lamy, Dupuis, and Ashby recognise as Blainville's *lineolatus*, and which specimens are clearly marked (in some cases evidently in the hand-writing of one of the collectors) as coming from King Island, are not that shell at all, but another species described by Blainville under the name *elongatus*, but of which the locality was quite unknown to Blainville.

Iredale and Hull then would have us believe that these specimens that are so clearly marked as from King Island did not come from that place at all, but came from an entirely different locality, which they designate as Kangaroo Island, in the State of South Australia, a contention that is unsupported by the smallest fact or probability.

Note.—If Messrs. Iredale and Hull are desirous of recognising Blainville's *elongatus* in some shell collected by Peron and Lesueur that is still preserved in the Paris Museum, then, as far as the description is concerned, they could well fix upon *Ischnochiton (Heterozona) subviridis*, Iredale and May, of which there are several examples in the collection. The one objection to this course is that Blainville gives no locality save "Australian Seas" for his *elongatus*. I personally agree with Pilsbry, that the description of *elongatus* is insufficient for determination. But if Iredale and Hull still desire to recognise *elongatus*, Blainville, as a known species, I designate *I. subviridis* Iredale and May, as the only unrecognised shell in the collections that I saw that will fit the description.

The specimens referable to this species, that I examined there, are half-grown shells that need cleaning, and are therefore difficult of determination. When examining them I came to the conclusion that, Blainville had probably considered them conspecific with his *lineolatus* (the southern form of *crispus)*. I still think this is so, but there is still the possibility that he may have named his *elongatus* from a specimen of *subviridis* from which the locality tablet had become separated. The shell Iredale and Hull call *Ischnochiton elongatus*, Blainville, is, without doubt, as has been amply shown, *Ischnochiton (Chiton) lineolatus*, Blainville.

Callistochiton antiquus, Reeve. Type, from Australia. This is certainly conspecific with specimens from Port Jackson in my own collection with which I compared them.

Plaxiphora petholata, var. *modesta* (Cpr. MS.). Type. This is the smooth form we have commonly called *glauca*, Quoy and Gaimard.

Plaxiphora petholata, var. *tasmanica* (Cpr. MS.). Type. This is a very highly sculptured form with double ribs, almost like *conspersa* from Port Lincoln, but we have the same double-ribbed form from Gulf St. Vincent; the type is said to have come from Tasmania.

Plaxiphora (Chaetopleura) conspersa, Ad. and Ang. Type, from Port Lincoln, 26th Oct., 1870. This is the highly sculptured form of *Plaxiphora* collected by the writer at the same locality.

Frembleya egregia, Adams. Type is supposed to have come from Australia, but is undoubtedly the New Zealand shell known under this name.

Spongiochiton productus, Carpenter. Type, marked as from New Zealand, but is considered to have come from Africa. My notes read, "Is something like

Craspedochiton laqueatus, Sowerby, but has an irregular girdle like *Loricella* or *Placiphorella*." The dorsal area is worn but probably had two deep longitudinal sulci bordering that area, which is narrow and strongly pinnatifid. The lateral and pleural areas in *productus* are closely covered with very large rounded granules; the diagonal rib is only indicated by a wave.

Acanthochiton carinatus, Ad. and Ang. Type, described as from Port Jackson. This is a large broad shell, decorated with closely packed granules and having a narrow, smooth, dorsal area. *Note.*—Iredale believes that it is the British shell *A. descrepans*.

Acanthochiton asbestoides, Smith. Type, from Flinders Island, Tasmania. Is conspecific with specimens in my collection from southern Tasmania, and from Wilson's Promontory, in Victoria.

Acanthochiton (Notoplax) speciosus, Adams. Type, from Tasmania. This is the shell we know under the same name from South Australia; the coarser radial granules are present in the anterior valve.

Acanthochiton (Notoplax) costatus, Ad. and Ang Type In one example the diagonal rib is furnished with small granules, in the other these granules are long and coalesced. In both, the radial ribs in the anterior valves are composed of long, coalesced granules. I have similar specimens from New South Wales.

Choriplax grayi, Ad. and Ang. Type, from Port Jackson. This differs from *Choriplax pattisoni*, Ashby, in that it is very much longer and narrower in proportion, it is more arched than *pattisoni*, and the articulamentum is barely joined across the central line, whereas in *pattisoni*, the heart-shaped tegmentum is placed well back from the edge of the articulamentum.

Whereas I described *Choriplax pattisoni* as a subspecies of *grayi*, the examination of the unique specimen of the latter in the British Museum determines me to recognise it as a distinct species. We have, therefore, this interesting fact, that this remarkable genus is only known from two specimens, one collected by Angas at Port Jackson in 1864, and the other collected by Pattison at Cape Banks, in South Australia, in 1921, and that these unique specimens represent two distinct species. In the paper accompanying the description of *C. pattisoni* (Trans. Roy. Soc. S. Austr., vol. xlv., 1921, pp. 136-142, pl. ix.) the writer shows that the true place in the Natural Taxis of this genus is near to the North American genus *Cryptochiton*. Instead of the insertion plates being absent in *Choriplax*, as was thought by earlier writers, they are highly developed, the slits have become obsolete, an extension of the girdle mantle covering the whole of the upper shell, except the heart-shaped fragment of the subobsolete tegmentum. In *Cryptochiton* we have the same highly developed insertion plates, the slits have become subobsolete, the tegmentum has become completely obsolete, and a similar extension of the girdle mantle covers the whole of the upper shell. It is not necessary to assume that the one genus has been derived through the other, but I consider that both are specialised forms derived from an Acanthoid stock, and would suggest that the extraordinary modifications of structure that are common to both have been brought about independently along parallel lines through a process of adaptation to very similar ecological conditions.

Chiton (Rhyssoplax) aureo-maculata, Bednall and Matthews. The type was lost; the specimen sent by the authors as being the same as the type is a variety of *tricostalis*, Pilsbry, and I consider that *aureo-maculata* is only a colour variety of that species.

Sypharochiton (Chiton) sinclairi, Gray. Type from New Zealand sent by Dr. Sinclair and figured in "Voyage of Erebus and Terror." The type is similar

to shells in my collection from Doubtless Bay, New Zealand, except a little faded. I could not separate them from some of the smooth forms from Tasmania. Iredale informed me that in New Zealand the highly sculptured form never varies into *sinclairi.* I consider that the forms grade into one another in Tasmania, but the *sinclairi* from the Dominion are a little more carinated than most of the Tasmanian shells, but in selected examples they can almost, if not quite, be paired. Iredale also stated that the girdle scales in *sinclairi* are always polished.

Amaurochiton glaucus, Gray. Type. This is undoubtedly the shell we know under this name from New Zealand and Hobart, Tasmania.

Lorica volvox, Reeve. Probably the type, but is now marked *cimolea,* from Sydney. It agrees with the figure in "Conch. Icon., Reeve," and is a typical Port Jackson shell which we know under the same name.

Lorica cimolea, Reeve. Probably the type. It corresponds with the shells we know under this name from South Australia.

Loricella angasi, H. Adams. Type. This is evidently a washed shore shell, showing some of the finger-like processes at the girdle margin, but all "spear-head" spicules are missing.

Acanthopleura (Chiton) cumminghami, Reeve. Type. This shell is said to have come from Australia, but it is not the shell known as *Acanthopleura gemmata,* Blainville; has a different insertion plate in the tail valve, is of the *Amphitomura* type, and cannot be considered an Australian shell.

Tonicia (Lucilina) truncata, Sowerby. Type, 1841. The sculpture of the pleural area is very similar to *delecta,* Thiele, only smoother; there is no radial ribbing in the lateral area, the broken diagonal rib in the median valves is duplicated at the posterior margin, the trough between these two ribs being densely sprinkled with eye spots.

Tonicia (Lucilina) carpenteri, Angas, 1867. Type, said to be from Port Jackson; the pleural area is the same as *delecta* and the lateral area shows ribbing.

Tonicia (Lucilina) fortilirata, Reeve, 1847. Type, from Torres Strait. Both lateral and pleural areas are similarly sculptured to *delecta,* but the sculpture is a little stronger.

Tonicia picata, Reeve, now *shirleyi,* Iredale, the name *picata* having been preoccupied. This is a smoother form than the preceding and appears conspecific with *truncata,* Sowb., but as the latter came from the Philippines and *shirleyi* from Queensland, it may be preferred to retain *shirleyi* as a separate race.

Tonicia jugosulcata (Cpr. MS.). Type. This specimen has not a truncated tail valve and belongs to a different group to the foregoing; it is alleged to have come from Tasmania, but the locality is probably incorrect, is most likely non-Australian.

In conclusion.—We find that the northern forms of *Tonicia* very variable, and it is quite possible that there exist intermediate grades from the highly sculptured *fortulirata* through *delecta, carpenteri, shirleyi* to *truncata,* all having a similar truncated tail valve, but for the present it seems desirable to recognise two Australian forms of this type:—

(1) *Tonicia (Lucilina) fortulirata,* Reeve, 1847 (Conch. Icon., pl. 18, f. 112), with syn. *carpenteri,* Angas, 1867, and syn. *delecta,* Thiele, 1911.

(2) *Tonicia (Lucilina) truncata, shirleyi,* Iredale, syn. *picata,* Reeve. No. 1 representing the highly sculptured varieties and No. 2 the smoother, but both groups having similarly truncated tail valves.

The third recognised Australian *Tonicia* is ***hullianus,*** Torr, which is a distinct type, up till the present only known from the type example collected by Dr. Torr in south-western Australia, and a second specimen collected by the writer in the same locality.

Onithochiton (Chiton) rugulosus, Angas, 1867. Type, from Port Jackson. This is conspecific with examples in my collection from the same locality and was described by Gould, in 1846, under the name *quercinus.*

Onithochiton (Chiton) incei, Reeve. Type, from Torres Strait. This also in conspecific with shells from Port Jackson, known as *Onithochiton quercinus,* Gould.

Onithochiton (Chiton) lyelli, Sowerby, 1832. Type was from Pitcairn Island. Although it is near *quercinus,* Gould, it appears a distinct species. I saw specimens from Perth, presented by Gould; these are evidently Thiele's *scholvieni.*

Sclerochiton miles and other types have been dealt with in earlier papers by the writer.

ABSTRACT OF PROCEEDINGS

OF THE

ROYAL SOCIETY OF SOUTH AUSTRALIA
(Incorporated)

FOR THE YEAR NOVEMBER 1, 1923, TO OCTOBER 31, 1924.

ORDINARY MEETING, NOVEMBER 8, 1923.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

PAPERS.—"The Ecology of the Eucalyptus Forests of the Mount Lofty Ranges," by R. S. ADAMSON, M.A., B.Sc., and Professor T. G. B. OSBORN, D.Sc.; "Résumé of H. R. Marston's report on his researches on the Azine and Azonium Precipitates of the Proteolytic Enzyime Trypsin," communicated by Professor T. B. Robertson. [See vol. xlvii., p. 400.]

EXHIBITS.—Mr. A. M. LEA exhibited the following insects:—(1) A number taken in ants' nests; (2) A collection made by Professor F. Wood Jones; (3) Moths from Fiji very destructive to cocoanuts.

ORDINARY MEETING, APRIL 10, 1924.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

RESIGNATION.—Mr. A. M. Lea resigned his position on the Council, as he was leaving the State for a year to undertake an investigation for the Fijian Government. The resignation was accepted, and Sir Joseph Verco, F.R.C.S., was elected in his stead.

INVITATIONS.—From Royal Society, London, inviting our Fellows to attend any of its meetings during this year without introduction; also from the Franklin Institute asking for a representative to attend its Centenary celebrations next September. The PRESIDENT reported that during the recess we had been asked to send a representative to the Centenary in May of the Linnaean Society, Normandy, and of the Society of Antiquaries, Normandy, and to the seven-hundredth anniversary of the University of Naples; also to the Jubilee of the Physical Society, London, in March. To the last of these the Council had appointed our Hon. Fellow, Professor Sir W. H. Bragg, as our representative.

FAUNA AND FLORA BOARD.—The PRESIDENT reported that at the invitation of the Government the Council had nominated for appointment on this Board Mr. Edgar R. Waite, F.L.S., C.M.Z.S., in place of Capt. S. A. White, C.M.B.O.U., who retired by effluxion of time.

PRESENTATION TO EDITOR.—The PRESIDENT read a letter from Sir Joseph C. Verco referring to the eminent service rendered to the Society by Professor Walter Howchin, F.G.S., who had for the last 23 consecutive years, and for seven previous years, acted as Honorary Editor of the Society's publications in such a way as to bring great credit to himself and to the Society. In slight recognition of his work he handed to the Professor a cheque which had been subscribed by Fellows of the Society. Professor RENNIE and Dr. R. S. ROGERS endorsed the remarks of the President. Professor HOWCHIN suitably responded.

PAPERS.—"Notes on Australian Crustacea, No. II., Family Gnathiidae," by HERBERT M. HALE; "Studies in Australian Aquatic Hemiptera: No. IV., The Corixid Genus Diaprepocoris," by HERBERT M. HALE; "Chalcidoidea and Proctotrupoidea from Lord Howe and Norfolk Islands, with descriptions of New Genera and Species," by ALAN P. DODD; "The Flora and Fauna of Nuyts Archipelago and the Investigator Group: No. 15, The Pearson Island Rat and the Flinders Island Wallaby," by F. WOOD JONES, D.Sc., etc.

EXHIBITS.—Mr. E. R. WAITE exhibited an example of *Dactylosargus arctidens,* a cirrhitoid fish not previously recorded from South Australia. Mr. N. B. TINDALE showed a collection of insects taken on Flinders Island by Professor F. Wood Jones and Dr. T. D. Campbell. A small brachelytrous cockroach, which is also probably new, and the blue butterfly, *Zizinal labradus.* Dr. R. H. PULLEINE exhibited four skulls of Tasmanian aborigines collected on his recent tour.

ORDINARY MEETING, MAY 8, 1924.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTIONS.—J. W. Browne, B.A., M.B., B.Ch.; C. T. Ch. de Crespigny, M.D., D.Sc.; P. S. Messent, M.B., B.S.; Prof. A. J. Perkins; P. W. Rice, M.B., B.S.; and Wallace Sandford, as Fellows.

NOMINATIONS.—R. W. Segnit, B.A., B.Sc.; P. S. Hossfeld; Fred. N. Simpson; and W. R. Cavenagh-Mainwaring, M.B., Ch.B., were nominated as Fellows.

The PRESIDENT reported that he had listened-in on May 6 to the annual address given by the President of the Royal Society of N.S. Wales in Sydney (Mr. R. H. Cambage, F.L.S.) on "Liquid Fuels." The President went to the Adelaide Radio Company's station at Millswood, where the address was heard very distinctly. It was resolved that letters of thanks be forwarded to those concerned. Messrs. W. J. Kimber and W. H. Baker were appointed delegates to the Council of the Australasian Association for the Advancement of Science Adelaide meeting, August 25-31 (inclusive), 1924.

PAPERS.—"Australian Anobiides," by A. M. LEA, F.E.S.; "*Blackburniella,* nov. nom. for *Thanasimomorpha,* Blackb.," by E A. CHAPIN, Ph.D., communicated by A. H. Elston, F.E.S.; "Flora and Fauna of Nuyts Archipelago and the Investigator Group: No. 16, The Crustacea," by H. M. HALE.

EXHIBITS.—Mr. W. J. KIMBER exhibited a number of shells and fossils found by him at Blanche Point, Port Willunga. Mr. E. R. WAITE exhibited, from the Museum, specimens of the Dummy Mourning Caps of the Murray River natives. Widows' caps have long been known, but objects now known to be dummies have not been previously identified as such. These were brought to the graves by relatives or friends and deposited one by one after the widow had placed her cap on the burial ground. Dr. R. H. PULLEINE showed a cylindro-conical stone from Arcoona Station, near Kimba, establishing a new western range for these aboriginal objects. Also specimens of a spider, *Ectatostica troglodites,* from the Mole River caves, W.A., two and a half inches long, and almost the largest in Australia.

ORDINARY MEETING, JUNE 12, 1924.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTIONS.—R. W. Segnit, B.A., B.Sc.; P. S. Hossfeld; F. N. Simpson; and W. R. Cavenagh-Mainwaring, M.B., Ch.B., as Fellows.

NOMINATIONS.—C. A. S. Hawker; C. Pearce; A. J. Morison; and Miss M. T. P. Roeger, as Fellows.

THE LATE HON. SECRETARY.—Dr. R. S. ROGERS, M.A., read an obituary notice of the late Hon. Secretary, which will be printed in the Transactions for 1924.

It was resolved that the election of a Hon. Secretary be postponed until the Annual Meeting, and that Mr. E. H. Ising be Acting Hon. Sec. until then.

PAPERS.—"Chiton Fauna (Polyplacophora) of Port Stephens, N.S. Wales," by E. ASHBY, F.L.S., M.B.O.U.; "Pouch Embryos of Marsupials: No. 8, *Dendrolagus matschiei*," by F. WOOD JONES, D.Sc., etc.; "On the Discovery of Supposed Aboriginal Remains near Cornwall, Tasmania," by R. H. PULLEINE, M.B.; "An Unrecorded Type of Aboriginal Stone Object," by T. D. CAMPBELL, D.D.Sc.

EXHIBITS.—Chitons obtained at Port Stephens by Mr. ASHBY. Paintings of native flowers from Port Stephens executed by Miss A. Ashby. Peculiar sponges of the genus *Thorecta* obtained by Mrs. C. Pearce at Port Willunga. A living blind snake (*Typhlops australis*) shown by Mr. E. R. WAITE, who stated that the thorn-like scale at the end of the tail was for facilitating a passage through the soil. Sir DOUGLAS MAWSON showed a field microscope devised by Dr. Goldschmidt, of Christiana University, portable, light, and of high quality. Dr. CLELAND exhibited a live python, 5 feet long, harmless and docile, obtained at Cordillo Downs; also two cylindrical aboriginal stones, one 21¾ inches long, from near Tinga Tingana, obtained through Mr. Patterson. Rev. J. C. JENNISON showed some rope made from the bark of a tree called by the natives of Elcho Island *balgoro*, known as the sandpaper tree. Prof. T. HARVEY JOHNSTON exhibited, on behalf of Dr. Cleland, a freshwater sponge from 80 miles north of Cooper Creek, tape worms from the dingo, and black sand-flies.

ORDINARY MEETING, JULY 17, 1924.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTIONS.—C. A. S. Hawker; C. Pearce; A. J. Morison; and Miss M. T. P. Roeger, as Fellows.

NOMINATIONS.—F. R. Guinnane and Wm. D. Walker, B.Sc., as Fellows.

PAPERS.—"External Characters of Pouch Embryos of Marsupials: No. 9, *Phascolomys tasmaniensis*," by F. WOOD JONES, D.Sc., etc.; "Some New Records of Fungi for South Australia, Part 3," by GEOFFREY SAMUEL, B.Sc., etc.

EXHIBITS.—A volume (No. 2) of some South Australian structural geology photographs, presented to the Society by Mr. J. Greenlees, c/o Amalgamated Zinc Co., Broken Hill. Dr. T. D. CAMPBELL showed a series of marked stones from Normanville, possibly indicating glacial action. Dr. PULLEINE exhibited two stones from Normanville, also one hand axe and three choppers from Tasmania. Dr. A. M. MORGAN showed a slate object from Normanville, also a stone axe and rough chopper from near Robe. Mr. E. R. WAITE, on behalf of the Museum, exhibited a series of Australian River tortoises, and drew attention to certain peculiarities in their structure, features found only in another genus from South America. Professor W. HOWCHIN exhibited the internal cast of a large fossil gasteropod shell, probably *Pleurotomaria*, obtained from the older marine Tertiary of South Australia, which showed that during the life of the mollusc the shell had been riddled by the small boring sponge *Cliona*, which is easily recognised from its pin-shaped spicules. Professor Howchin also showed what were equivalent to money tokens as used in the islands of New Guinea; low values are represented in small perforated circular discs, made from shells, 28 of which, according to the Rev. J. R. Andrew (who presented them to him)

represent a value of about 7s. 6d.; larger values, by highly finished and polished stone implements, not used as tools, one of which, equal to about 30s., was shown. This is an interesting example of primitive forms of exchange; it is not barter, which is an exchange of commodities, but a conventional system of exchange based on the equivalent of work represented in the objects used for payment.

ORDINARY MEETING, AUGUST 14, 1924.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTIONS.—F. R. Guinnane and W. D. Walker, B.Sc., as Fellows

PAPER.—"On the Specialized Incisor Teeth of some of the Didactylous Marsupials," by Professor F. WOOD JONES, D.Sc., etc.

EXHIBITS.—Dr. LENDON exhibited two pieces of pottery made by the so-called cave-dwellers at Atalaya, in the Grand Canary, who are said to be a remnant of the aborigines, the Guanches; also fragments of pottery from the excavations at Knossos, in Crete, on the site of the Palace of Minos. Mr. W. J. KIMBER showed, from Port Lincoln, a series of *Scapha fulgetrum*, South Australia's largest volute. Mr. E. ASHBY exhibited a large collection of Central and South American Trogonidae, which are distinguished from the Picarian families chiefly by the structure of the tendons of the foot. Mr. P. S HOSSFELD showed several specimens from Ardrossan illustrating the variety of rocks in which Turritellae are found, and also one of silicified wood covered with small quartz crystals. Mr. H. M. HALE exhibited the common "yabbie," *Parachaeraps bicarinatus*, one specimen showing adaptation of colour to environment, another carrying young beneath the abdomen (not hitherto recorded), and a third showing malformed chelae, the result of injury received soon after moulting. Dr. T. D. CAMPBELL showed a number of worked stones from the native camp near the rifle butts at Fulham, chiefly scrapers and miniature chipped knives Dr. PULLEINE showed a pod of sea island cotton from the Northern Territory, and a cylindro-conical stone from Menindie, N.S. Wales. Mr. N. B TINDALE exhibited some nodules of calcified sand found at Ceduna, West Coast, together with recent ones containing the remains of beetles, showing that the nodules are the calcified pupal cases of the weevil, *Leptops duponti*.

INFORMAL MEETING, SEPTEMBER 11, 1924.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

As three full days' notice had not been given, this could not be an ordinary meeting of the Royal Society. It was resolved that the Papers be read and laid on the table, and be formally accepted as read at the next meeting.

NOMINATION.—I. G. Symons, as Fellow.

PAPERS.—"South Australian Expedition to Observe the Total Solar Eclipse on September 21, 1922, at Cordillo Downs, far N.E. of South Australia," by KERR GRANT, M.Sc., and G. F. DODWELL; "Revision of the Australian Elateridae (Coleoptera), Part I.," by A. H. ELSTON, F.E.S.; "The Relations between Distribution, Structure, and Transpiration of Arid South Australian Plants," by J. G. WOOD, B.Sc.; "Notes on Australian Crustacea, No. 3," by H. M. HALE; "New Genera and Species of Australian Stone-flies," by R. J. TILLYARD, M.A., D.Sc., etc., communicated by E. R. Waite, F.L.S.

EXHIBITS.—Mr. E. R. WAITE, on behalf of the S.A. Museum, showed the cast of an egg of the Deinosaur from Mongolia, sent by the American Museum of Natural History; also a skeleton of the Loggerhead Turtle *(Thalassochelys caretta)* from Port Noarlunga, a new record for South Australia, and a skeleton of a Green Turtle *(Chelone mydas)* for comparison.

ANNUAL MEETING, OCTOBER 9, 1924.

THE PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTION.—I. G. Symons, as Fellow.

The ANNUAL REPORT and FINANCIAL STATEMENT were read and adopted.

It was moved—"That a motion be placed on record that the position of President be held for one year only." An amendment was carried—"That consideration of the matter be deferred for twelve months."

ELECTION OF OFFICERS.—The following officers were elected for 1924-25:—*President*, Prof. Sir Douglas Mawson, D.Sc., F.R.S., etc.; *Vice-Presidents*, R. H Pulleine, M.B., and Prof. T. G. B. Osborn, D.Sc.; *Members of Council*, Prof Wood Jones, D.Sc., etc., Prof. J. B. Cleland, M.D., and L Keith Ward; *Hon Treasurer*, B. S. Roach; *Hon. Secretary*, C. Fenner, D.Sc.

PAPERS.—"The Relation of Climate to the Spread of Prickly Pear," by Professor T. HARVEY JOHNSTON, M.A., D.Sc; "Further Discoveries of Glacial Features near Hallett's Cove," by Professor WALTER HOWCHIN, F.G.S.; "Additions to the Flora of South Australia, No. 22," by J. M. BLACK; "Australian Fungi, Notes and Descriptions, No. 5," by Professor J. B. CLELAND, M.D.; "Notes on the Types of Australian Polyplacophora in the British Museum," by EDWIN ASHBY, F.L.S.; "Further Notes on Australian Polyplacophora, with descriptions of Three New Species," by EDWIN ASHBY, F.L.S.; "On a Notable Monazite-bearing Pegmatite, near Normanville," by R. GRENFELL THOMAS, B.Sc.; "Anthropometric and Descriptive Observations on some South Australian Aboriginals," by Professor F. WOOD JONES, D.Sc., etc., and Dr. T. D. CAMPBELL

ANNUAL REPORT

FOR YEAR ENDED SEPTEMBER 30, 1924.

During the year many important contributions in Natural Science were placed before the Society. In Botany, by Professor Osborn, J. M. Black, J. G. Wood, and E. H. Ising; in Mammalology, by Professor Wood Jones; in Entomology, by A. M. Lea, H. M. Hale, and A. H. Elston; in Anthropology, by Professor Wood Jones, Dr. T. D. Campbell, and Dr. R. H. Pulleine. Professor Howchin and Mr. R. G. Thomas presented papers on Geological features; Mr. E. Ashby continued his contributions on Polyplacophora; and Dr. Cleland on Fungi. Professor Kerr Grant gave an interesting account of the Eclipse Expedition to Cordillo Downs. A great number of interesting exhibits were tabled during the year.

The Library received two important donations during the year, one being a nearly complete set of Proceedings presented by the Royal Geographical Society; and a splendid reference map of South Australia, presented by the Minister of Crown Lands (Hon. G. R. Laffer), through the Surveyor-General.

Nothing has so far been done to provide additional shelving for our expanding Library, and as all available accommodation is taken up, this will require attention during the coming year. Fully 50 per cent. more shelving is urgently required.

Messrs. W. H. Baker and W. J. Kimber were elected as Delegates from our Society to the Council of the Australasian Association for the Advancement of Science, at the Adelaide meeting, in August of this year.

Sir Joseph Verco, on his return from abroad, was elected to the Council in the place of Mr. A. M. Lea, who resigned in April owing to absence from the State.

The death of Mr. Walter Rutt, C.E., for many years our invaluable Secretary and the oldest Fellow of the Society, occurred in May, 1924. Dr. R. S. Rogers is contributing a biographical notice of the deceased in this volume. Another Fellow, Dr. Melville Birks, elected in 1921, passed away during the year.

The attendances at meetings of Council have been as follows:—Prof. Howchin and Mr. Roach, 9; Prof. Wood Jones, Dr. Rogers, and Dr. Pulleine, 7; Prof. Osborn and Mr. Waite, 6; Profs. Cleland and Robertson, 5; Sir Joseph Verco and Sir Douglas Mawson, 4; the late Hon. Secretary, 4; Mr. Lea, 2.

Our present membership comprises 7 Honorary Fellows, 4 Corresponding Members, and 109 Fellows

ROBERT PULLEINE, *President.*

E. H. ISING, *Acting Hon. Secretary.*

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Revenue and Expenditure for 1923-24.

	£	s.	d.	£	s.	d.
To Balance, October 1, 1923				556	1	9
„ Subscriptions—						
Royal Society	109	4	0			
Field Naturalists' Section	52	5	3			
				161	9	3
„ Grants from Government—						
On Subscriptions	139	6	5			
For Printing Reports and Scientific Investigations	150	0	0			
				289	6	5
„ Receipts for use of Room by other Societies	5	13	6			
„ Sale of Publications	3	19	7			
				9	13	1
„ Savings Bank Interest	10	15	3			
„ Interest transferred from Endowment Fund	178	18	7			
				189	13	10
				£1,206	4	4

	£	s.	d.	£	s.	d.
By Transactions—						
Printing	361	19	0			
Illustrating	226	6	1			
Publishing	14	11	1			
				602	16	2
„ Grant—						
Field Naturalists' Section				50	0	0
„ Library—						
Librarian	37	8	9			
Book-binding	9	11	6			
				47	0	3
„ Sundries—						
Cleaning and Lighting	9	2	9			
Printing, Postages, Stationery	19	2	8			
Insurance	6	15	0			
Advertising	7	8	5			
Fee for filing Rules	0	5	0			
				42	13	10
„ Balance September 30, 1924—						
Savings Bank of S.A.	364	11	5			
Bank of Australasia	98	18	8			
Cash in Hand	0	4	0			
				463	14	1
				£1,206	4	4

Audited and found correct,

W. CHAMPION HACKETT, } Hon.
HOWARD WHITBREAD, } Auditors.

B. S. ROACH, Hon. Treasurer.

Adelaide, October 6, 1924.

ENDOWMENT FUND.

(Capital £3,844 6s. 10d.)

	£ s. d.	£ s. d.
1923—October 1.		
To Balance, S.A. Government Stock ..	.. 3,839 18 9	
Savings Bank	4 8 1	
		3,844 6 10
„ Interest received on Govt. Stock .. .	178 15 0	
Savings Bank	0 3 7	
		178 18 7
		£4,023 5 5

	£ s. d.	£ s. d.
1924—September 30		
By £2,000 S.A. Govt. Stock at 3¾ per cent.	1,997 10 0	
„ £800 S.A. Govt. Stock at 5½ per cent. ..	800 0 0	
„ £500 S.A. Govt. Consolidated 3 per cent. Stock	292 8 9	
„ £100 S.A. Govt. Stock at 5 per cent. ..	100 0 0	
„ £650 S.A. Govt. Stock at 5¾ per cent. ..	650 0 0	
„ Savings Bank Account	4 8 1	
		3,844 6 10
„ Revenue Account		.. 178 18 7
		£4,023 5 5

Audited and found correct.

W. CHAMPION HACKETT, } Hon.
HOWARD WHITBREAD, } Auditors.

B. S. ROACH, Hon. Treasurer.

Adelaide, October 6, 1924.

DONATIONS TO THE LIBRARY

FOR THE YEAR ENDED SEPTEMBER 30, 1924.

TRANSACTIONS, JOURNALS, REPORTS, ETC.,
presented by the respective governments, societies, and editors.

AUSTRALIA.

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AUSTRALIA. *Census and Statistics.* Yearbook, no. 16. Melb. 1923.
——— *Dept. of Health.* Service publication, no. 2-6, 8. Melb.
——— *Fisheries.* Bull., v. 5, pt. 3. Melb.
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——— *National Research Council.* Sci. abstracts, v. 2, no. 4; 3, no. 1-3.
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SOUTH AUSTRALIAN NATURALIST, v. 5, no. 1-4. Adel. 1923-24.
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MAIDEN, J. H. Critical revision of the genus Eucalyptus, pt. 62.
——— Forest flora of N.S.W., v. 8, pt. 4-6. Syd. 1923-24.
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——— *Botanic Gardens.* Report, 1921-22. Syd.
——— *Dept. of Agriculture.* Gazette, v. 34, pt. 10-12; 35, pt. 1-9.
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——— *Geological Survey.* Bull., no. 4-5, 8, suppl. Syd. 1923.
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TECHNOLOGICAL MUSEUM. Bull., no. 6, 8-9. Syd. 1923-24.

QUEENSLAND.

QUEENSLAND. *Dept. of Agriculture.* Journ., v. 20-21; 22, pt. 1-3.
——— *Geological Survey.* Publications, no. 274. Brisb. 1923.
QUEENSLAND MUSEUM. Mem., v. 8, pt. 1. Brisb. 1924.
ROYAL SOCIETY OF QUEENSLAND. Proc., v. 35. Brisb. 1924.

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MAY, W. L. Check-list of mollusca of Tasmania. Hobart.
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SCIENTIFIC AUSTRALIAN, v. 29, no. 5-12; 30, no. 1-5. Melb. 1923-24.
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——— *Geological Survey*. Bull., no. 42, 46-47, and maps. Melb.
VICTORIAN NATURALIST, v. 40; 41, no. 1-5. Melb. 1923-24.

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——— GEOLOGICAL SURVEY. Bull., no. 89. Perth. 1924.

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BRITISH ANTARCTIC EXPEDITION, 1910-13. Meteorology, v. 1-3.
——— Physiography, Robertson Bay, Terra Nova Bay, Beardmore Glacier, Ross Archipelago. Lond. 1923.
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BRITISH MUSEUM (NAT. HIST.). Economic ser., no. 13. Lond. 1922.
——— Selous collection catalogue. Lond. 1921.
CAMBRIDGE PHILOSOPHICAL SOCIETY. Proc., v. 21, pt. 6; 2, pt. 1. 1923-24.
——— Trans., v. 23, no. 2-3. Camb. 1924.
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ROYAL MICROSCOPICAL SOCIETY. Journ., 1923; 1924, pt. 1-2. Lond.
ROYAL SOCIETY. Proc., A724-36; B666-78. Yearbook, 1924. Lond.
UNITED EMPIRE, v. 14, no. 9-12; 15, no. 1-8. Lond. 1923-24.

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——— Trans., v. 53, pt. 2; 54, pt. 1. Edin. 1924.

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ROYAL IRISH ACADEMY. Proc., A, v. 33, pt. 6; 36, pt. 5-7; B, v. 33, pt. 4-6; 36, pt. 4-11; C, v. 33, pt. 12-19; 36, pt. 10-19. Dubl. 1917-24.

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NATURHISTORISCHEN HOFMUSEUMS. Ann., Bd. 36-37. Wien. 1923-24.
ZOOL.-BOT. GESELLSCHAFT. Verh., Bd. 64-69. Wien. 1914-19.

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ACADÉMIE ROYALE DE BELGIQUE. Ann. 1924. Brux.
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LIST OF FELLOWS, MEMBERS, ETC.

AS EXISTING ON SEPTEMBER 30, 1924.

Those marked with an asterisk have contributed papers published in the Society's Transactions

Any change in address should be notified to the Secretary.

Note.—The publications of the Society will not be sent to those whose subscriptions are in arrear.

Date of Election.

HONORARY FELLOWS.

1910. *BRAGG, SIR W. H., K.B.E., M.A., D.Sc., F.R.S., Professor of Physics, University College, London (Fellow 1886).
1893. *COSSMAN, M., 2 Boulvd. Sadi-Carnot, Enghien, France.
1897. *DAVID, SIR T. W. EDGEWORTH, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S., F.G.S., Professor of Geology, University of Sydney.
1905. *HEDLEY, CHAS., c/o University, Brisbane, Queensland.
1892. *MAIDEN, J. H., I.S.O., F.R.S., F.L.S., Turramurra Ave., Turramurra, N.S.W.
1898. *MEYRICK, E. T., B.A., F.R.S., F.Z.S., Thornhanger, Marlborough, Wilts, England.
1894. *WILSON, J. T., M.D., Ch.M., Professor of Anatomy, Cambridge University, England.

CORRESPONDING MEMBERS.

1913. *CARTER, H. J., B.A., Kintore Street, Wahroonga, N.S.W.
1909. *JOHNCOCK, C. F., Clare.
1905. THOMSON, G. M., F.L.S., 209 Cargill Street, Dunedin, New Zealand.
1908. *WOOLNOUGH, WALTER G., D.Sc., F.G.S. (Fellow 1902).

FELLOWS.

1895. *ASHBY, EDWIN, F.L.S., M.B.O.U., Blackwood.
1917. BAILEY, J. F., Director Botanic Garden, Adelaide
1902. *BAKER, W. H., F.L.S., King's Park.
1902. *BLACK, J. M., 82 Brougham Place, North Adelaide.
1912. *BROUGHTON, A. C., Moorlands, Tailem Bend.
1911. BROWN, EDGAR J., M.B., D.Ph., 172 North Terrace.
1883. *BROWN, H. Y. L., 286 Ward Street, North Adelaide.
1924. BROWNE, J. W., B.Ch., 169 North Terrace.
1916. *BULL, LIONEL B., D.V.Sc., Laboratory, Adelaide Hospital.
1923. BURDON, ROY S., B.Sc., University of Adelaide.
1921. BURTON, R. J., Fuller Street, Walkerville.
1922. *CAMPBELL, T., D.D.S., Dental Dept., Adelaide Hospital, Frome Road.
1924. CAVENAGH-MAINWARING, W. R., M.B., B.S., 207 North Terrace.
1907. *CHAPMAN, R. W., M.A., B.C.E., F.R.A.S., Professor of Engineering and Mechanics, University of Adelaide.
1904. CHRISTIE, W., c/o Griffiths Bros., King William Street, Adelaide.
1895. *CLELAND, JOHN B., M.D., Professor of Pathology, University of Adelaide.
1923. CONRICK, JOHN, Nappermerrie, Farina
1907. *COOKE, W. T., D.Sc., Lecturer, University of Adelaide.
1924. CRESPIGNY, C. T. C. DE, 172 North Terrace.
1916. DARLING, H. G., Franklin Street, Adelaide.
1887. *DIXON, SAMUEL, Bath Street, New Glenelg.
1915. *DODD, ALAN P., Prickly Pear Laboratory, Sherwood, Brisbane.
1921. DUTTON, G. H., B.Sc., F.G.S., 21 Da Costa Avenue, South Prospect.
1911. DUTTON, H. H., B.A., Anlaby.
1902. *EDQUIST, A. G., Second Avenue, Sefton Park.
1918. *ELSTON, A. H., F.E.S., "Hatherley," Commercial Road, Unley Park.
1917. *FENNER, CHAS. A. E., D.Sc., F.G.S., Education Department, Adelaide.
1914. FERGUSON, E. W., M.B., Ch.M., Gordon Road, Roseville, Sydney.
1923. FRY, H. K., M.B., B.S., B.Sc., Glen Osmond Road, Parkside.
1919. GLASTONBURY, O. A., Adelaide Cement Co., Brookman Buildings, Grenfell Street.
1923. GLOVER, C. R. J., Stanley Street, North Adelaide.
1904. GORDON, DAVID, 72 Third Avenue, St. Peters.
1880. *GOYDER, GEORGE, A.M., F.C.S., Gawler Place, Adelaide.
1910. *GRANT, KERR, M.Sc., Professor of Physics, University of Adelaide.
1922. GRANT, R. L. T., M.B., B.S., M.R.C.P., University of Adelaide.
1904. GRIFFITH, H., Hove, Brighton.
1924. GUINNANE, F. R., King Street, Brighton.
1916. HACKETT, W. C., 35 Dequetteville Terrace, Kent Town.
1922. *HALE, H. M., Irish Harp Road, Prospect.
1922. *HAM, WILLIAM, F.R.E.S., University of Adelaide.
1916. HANCOCK, H. LIPSON, A.M.I.C.E., M.I.M.M., M.Am.I.M.E., Angaston.

Date of Election.

1924. HAWKER, C. A. S., North Bungaree, via Yacka.
1896. HAWKER, E. W., F.C.S., East Bungaree, Clare.
1923. HILL, FLORENCE M., B.S., M.D., University of Adelaide.
1924. HOSSFELD, PAUL S., Carey Street, Magill.
1883. *HOWCHIN, Professor WALTER, F.G.S., "Stonycroft," Goodwood East.
1918. *ISING, ERNEST H., Locomotive Department, S.A. Railways, Mile End.
1912. *JACK, R. L., B.E., F.G.S., Assistant Government Geologist, Adelaide.
1893. JAMES, THOMAS, M.R.C.S., 9 Watson Avenue, Rose Park.
1918. JENNISON, Rev. J. C., 31 Kyre Avenue, Kingswood.
1910. *JOHNSON, E. A., M.D., M.R.C.S., 295 Pirie Street.
1910. *JOHNSTON, Professor T. HARVEY, M.A., D.Sc., University of Adelaide.
1920. *JONES, F. WOOD, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., Professor of Anatomy, University of Adelaide.
1923. JUDELL, LESTER M. W., B.Sc., Jamestown.
1918. KIMBER, W. J., 28 Second Avenue, Joslin.
1915. *LAURIE, D. F., Agricultural Department, Victoria Square.
1897. *LEA, A. M., F.E.S., South Australian Museum, Adelaide.
1884. LENDON, A. A., M.D., M.R.C.S., North Terrace.
1922. LENDON, GUY A., M.B., B.Sc., M.R.C.P., North Terrace.
1888. *LOWER, OSWALD B., F.Z.S., F.E.S., Broken Hill, New South Wales.
1922. MADIGAN, C. T., B.A., B.Sc., University of Adelaide.
1923. MAGAREY, W. A., LL.B., Pirie Street.
1923. MARSHALL, J. C., Payneham.
1914. MATHEWS, G. M., F.R.S.E., F.L.S., F.Z.S., Foulis Court, Fair Oak, Hants, England.
1905. *MAWSON, SIR DOUGLAS, D.Sc., B.E., F.R.S., Professor of Geology, University, Adelaide.
1919. MAYO, HELEN M., M.B., B.S., 47 Melbourne Street, North Adelaide.
1920. MAYO, HERBERT, LL.B., Brookman Buildings, Grenfell Street.
1923. McBRIDE, R. M., J.P., 14 Giles Street, Toorak.
1920. McGILP, JOHN NEIL, Napier Terrace, King's Park.
1907. MELROSE, ROBERT T., Mount Pleasant.
1924. MESSENT, P. S., M.S., 192 North Terrace.
1897. *MORGAN, A. M., M.B., Ch.B., 46 North Terrace.
1924. MORISON, A. J., Deputy Town Clerk, Town Hall, Adelaide.
1921. MOULDEN, OWEN M., M.B., B.S., Broken Hill, N.S.W.
1913. *OSBORN, T. G. B., D.Sc., Professor of Botany, University of Adelaide.
1924. PEARCE, C., 33 Capper Street, Kent Town.
1924. PERKINS, A. J., Director of Agriculture, Victoria Square.
1907. *PULLEINE, R. H., M.B., North Terrace.
1916. RAY, WILLIAM, M.B., B.Sc., A.M.P. Chambers, King William Street.
1885. *RENNIE, EDWARD H., M.A., D.Sc., F.C.S., Professor of Chemistry, University, Adelaide.
1924. RICE, P. W., M.B., B.S., 137 Henley Beach Road, Mile End.
1911. ROACH, B. S., Education Department, Flinders Street.
1919. *ROBERTSON, Professor T. B., University of Adelaide.
1924. ROEGER, Miss M. T. P., Gaza.
1905. *ROGERS, R. S., M.A., M.D., 52 Hutt Street.
1922. *SAMUEL, GEOFFREY, B.Sc., University of Adelaide.
1924. SANDFORD, J. WALLACE, 75 Grenfell Street.
1924. SEGNIT, R. W., B.A., B.Sc., Architect-in-Chief's Office, King William Street.
1891. SELWAY, W. H., Treasury, Adelaide.
1920. SIMPSON, A. A., C.M.G., Lockwood Road, Burnside.
1924. SIMPSON, FRED. N., Dequetteville Terrace, Kent Town.
1906. SNOW, FRANCIS H., National Mutual Buildings, King William Street.
1923. SPROD, M. W., M.B., B.S., Mannum.
1910. *STANLEY, E. R., Government Geologist, Port Moresby, Papua.
1923. STRONG, Professor ARCHIBALD, M.A., D.Litt., University of Adelaide.
1922. SUTTON, J., Fullarton Road, Netherby.
1923. THOMAS, J. F., 64 Elizabeth Street, Sydney.
1923. *THOMAS, R. G., 5 Trinity Street, St. Peters.
1921. *TIEGS, OSCAR W., M.S., D.Sc., University of Adelaide.
1923. *TINDALE, N. B., South Australian Museum, Adelaide.
1894. *TURNER, A. JEFFERIS, M.D., F.E.S., Wickham Terrace, Brisbane, Queensland.
1878. *VERCO, SIR JOSEPH C., M.D., F.R.C.S., North Terrace.
1914. *WAITE, EDGAR R., F.L.S., C.M.Z.S., Director, South Australian Museum.
1924. WALKER, W. D., B.Sc., 65 Second Avenue, St. Peters.
1912. *WARD, LEONARD KEITH, B.A., B.E., Government Geologist, Adelaide.
1904. WHITBREAD, HOWARD, c/o A. M. Bickford & Sons, Currie Street.
1912. *WHITE, Capt. S. A., C.M.B.O.U., "Wetunga," Fulham.
1920. *WILTON, Professor J. R., D.Sc., University of Adelaide.
1923. *WOOD, J. G., B.Sc., University of Adelaide.

APPENDIX.

FIELD NATURALISTS' SECTION

OF THE

Royal Society of South Australia (Incorporated).

FORTY-FIRST ANNUAL REPORT OF THE COMMITTEE

FOR THE YEAR ENDED AUGUST 31, 1924.

GENERAL.—The work of the year has been well maintained, ten Lectures were given and Excursions were held fortnightly throughout the year. The subjects studied during the various excursions have been:—Astronomy, Sea Life, Physiography, Botany, Conchology, Ornithology, Fossils, and Forestry.

NATURAL HISTORY SURVEY OF THE NATIONAL PARKS AND RESERVES.—An attempt has been made, this year, to make a survey of the local parks and reserves, and so far three trips have been made to the National Park, Belair, and one each to Morialta and Waterfall Gully. Lists of the indigenous and naturalised flora are being prepared, and these will be brought up to date after subsequent visits. Mr. J. Sutton has offered his list of birds, and Dr. C. Fenner has agreed to write on the physiography and geology of the areas under survey. It is intended to print an account in "The S.A. Naturalist" of the work done with lists attached.

PLANT SURVEY AND HERBARIUM.—This subcommittee has had a busy time; several meetings were held and the Herbarium keepers and others have accomplished much good work in sorting out specimens. Cardboard boxes have been purchased, and Mr. J. F. Bailey has kindly presented a quantity of specimen folders. Specimens have been received from many parts of South Australia. Most of these are awaiting classification. The Royal Society granted £15 for this work, and about half the amount has been spent on boxes, cards, etc.

MEMBERSHIP.—On October 1, 1923, there were 185 members on the roll, and on September 1 this year there are 217 members. New members elected during the period were 43; the losses by resignation and death were several.

FLOWER SHOW, 1923.—The net proceeds were £25 15s. 8d. We are greatly indebted to the Lord Mayor for granting the use of the Town Hall on payment of working expenses. Only for this the Show would have resulted in a financial loss.

OUR JOURNAL.—"The South Australian Naturalist" has been issued regularly under the capable editorship of Mr. Wm. Ham, and volume V. was completed with the publication of the August number.

LIBRARY.—Members have made good use of the books, which have so increased as to make the cupboard in which they are stored quite inadequate. The Librarian makes a plea for a larger and more suitable cupboard.

(Signed) J. B. CLELAND, *Chairman.*
E. H. ISING, *Hon. Sec.*

FIELD NATURALISTS' SECTION OF THE ROYAL SOCIETY.

Statement of Receipts and Expenditure for Year ended August 30, 1924.

GENERAL ACCOUNT.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
To Balance Brought Forward	6	14	2	By Postages	14	11	3
„ Wild Flower Show	27	19	0	„ Printing	45	2	3
„ Subscriptions	52	12	3	„ Stationery	6	4	3
„ Grant	50	0	0	„ Wild Flower Show Prizes	2	3	4
„ Sale of Badges, etc.	1	7	8	„ Library Books	0	10	0
„ Bank Interest	0	16	6	„ Advertising	1	3	0
„ Additional Subscriptions in hand	1	2	6	„ Hire of Hall	6	3	1
				„ Telegrams, etc.	0	8	6
				„ Subscriptions paid to Royal Society	52	5	3
				„ Balance in Bank due to Royal Society	1	2	6
				„ Cash in Hand	0	7	0
				„ Balance in Bank	10	11	8
	£140	12	1		£140	12	1
Subscriptions due to Royal Society	1	9	6				
Balance	10	11	8				

EXCURSION ACCOUNT.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
To Balance Brought Forward	3	18	9	By Hire of Motors	66	10	0
„ Fares	74	16	9	„ Refreshments, etc.	1	0	3
				„ Hire of Launches	7	0	0
				„ Tips to Sailors	1	0	0
				„ Balance	3	5	3
	£78	15	6		£78	15	6
To Balance	£3	5	3				

Audited and found correct,

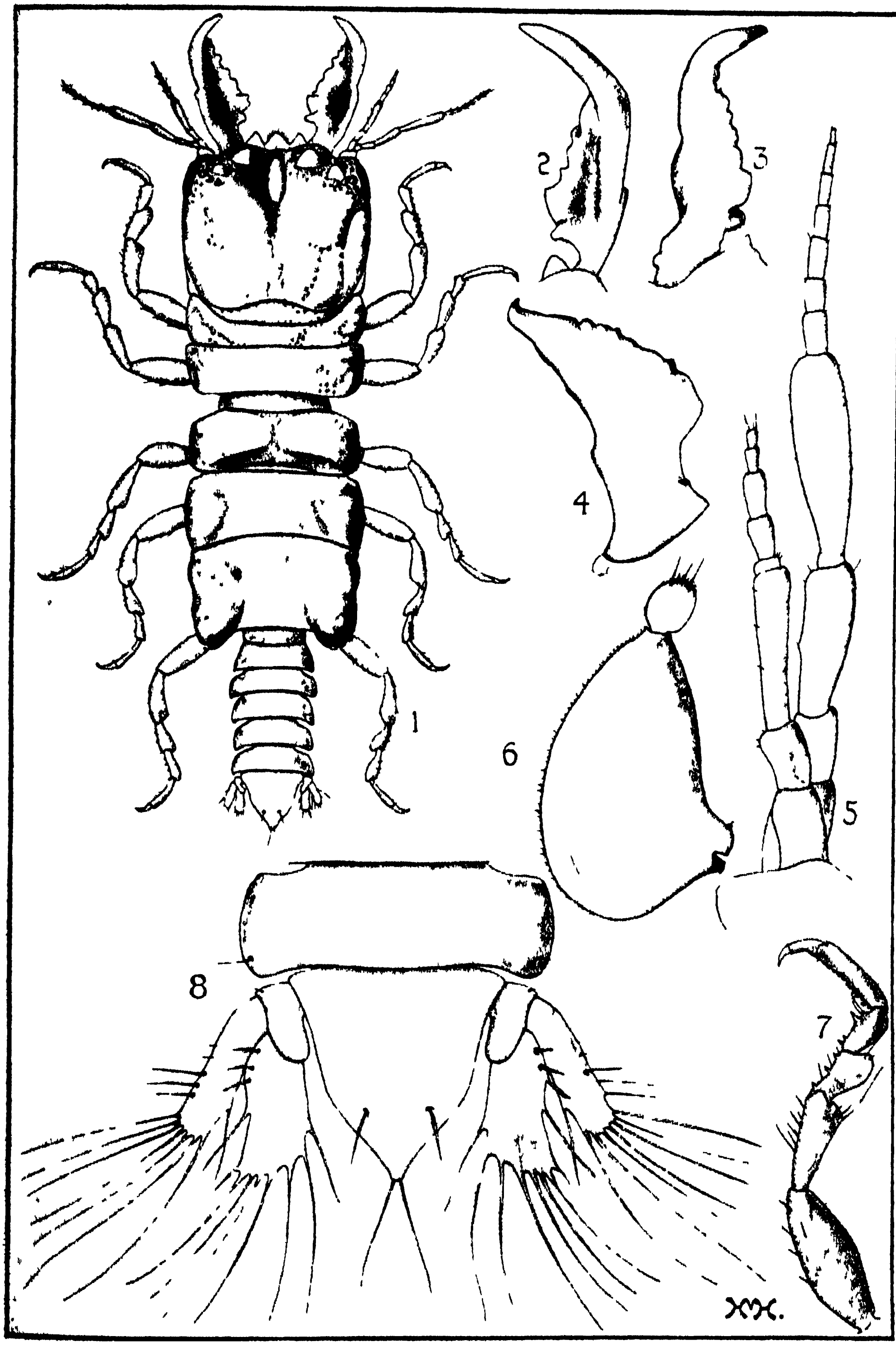
(Signed) WALTER D. REED, F.C.P.A., } Hon.
A. J. MORISON, } Auditors.

BEAVIS B. BECK, Hon. Treasurer.
E. H. ISING, Hon. Sec.

Adelaide, September 15, 1924.

GENERAL INDEX

[Generic and specific names in italics indicate that the forms described are new to science.]



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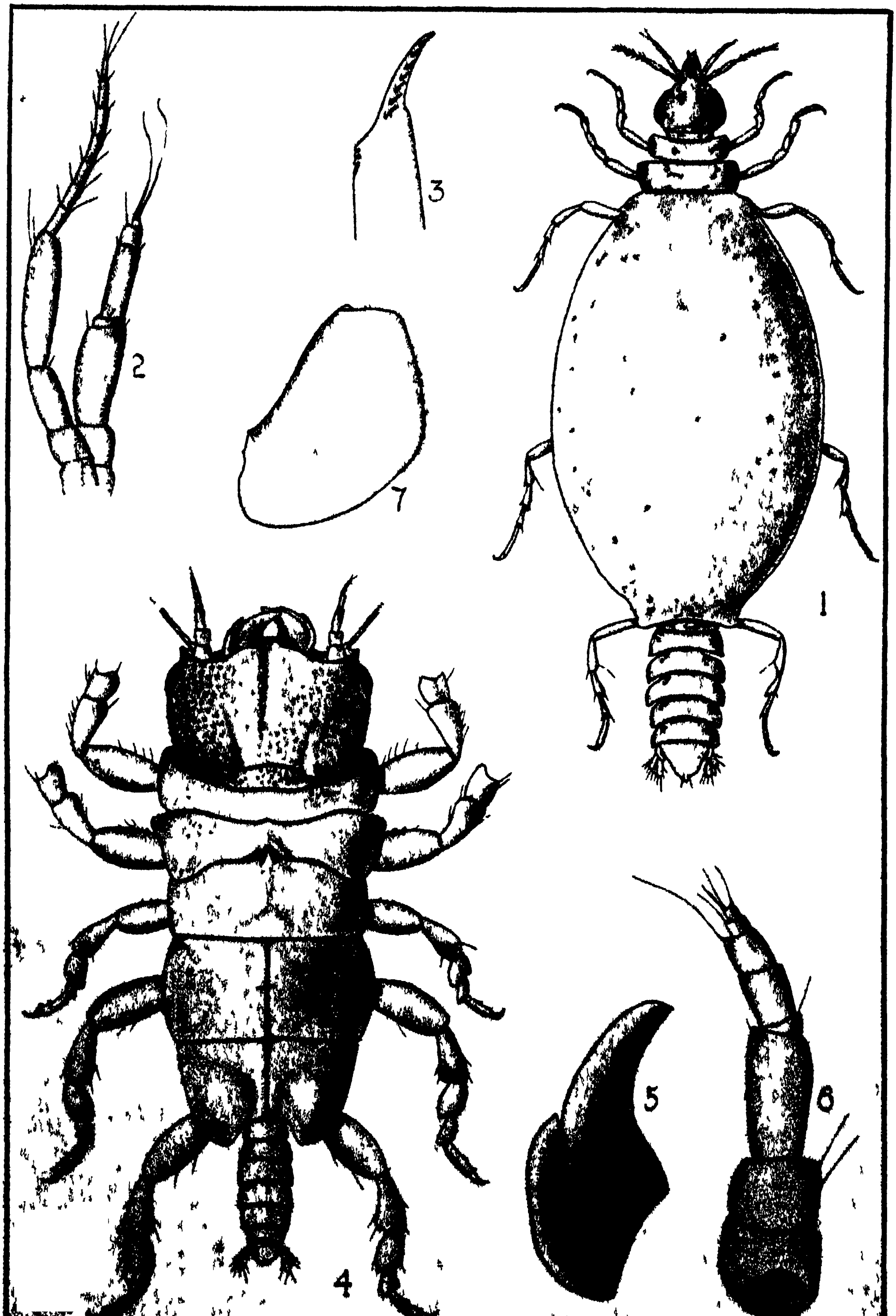

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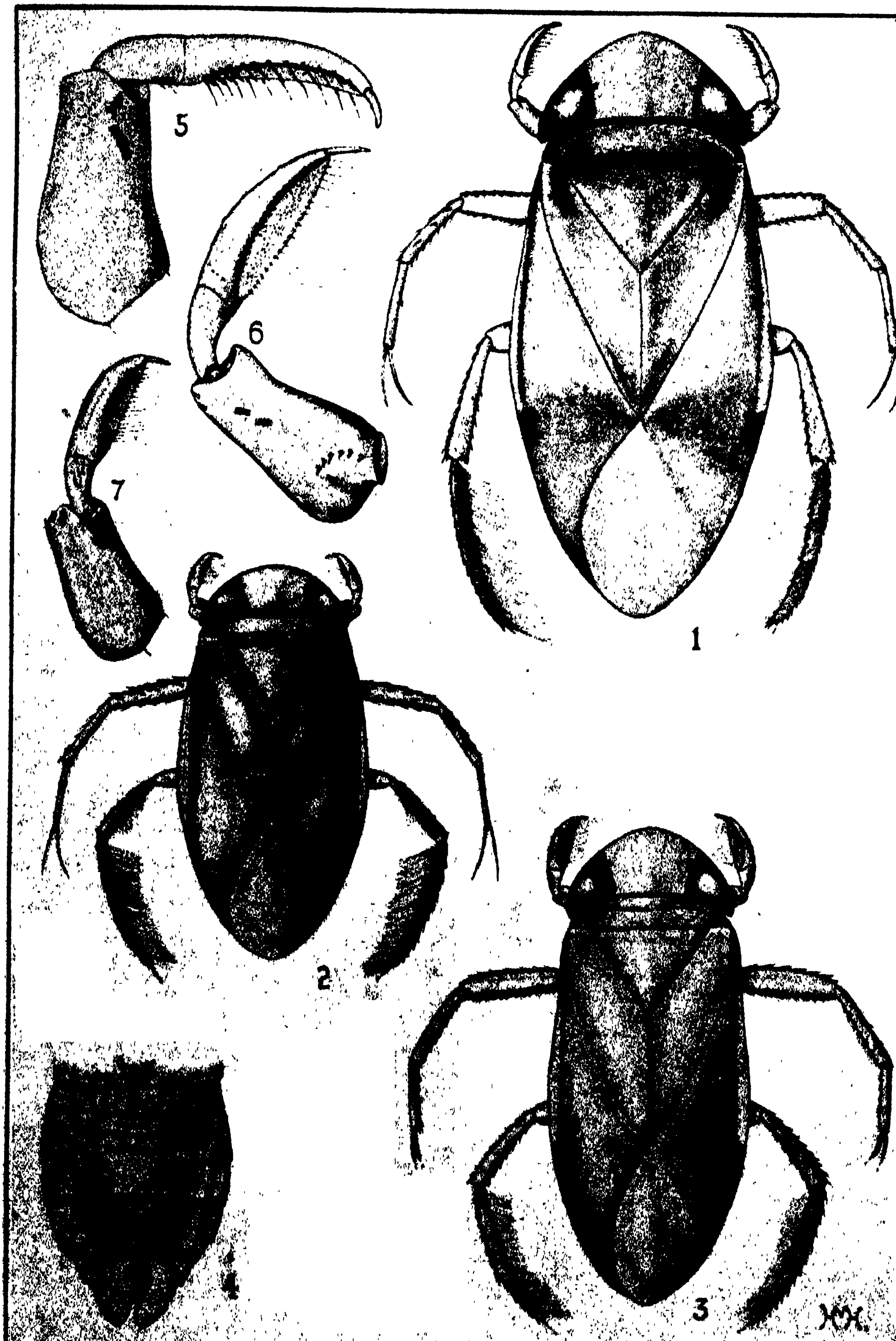

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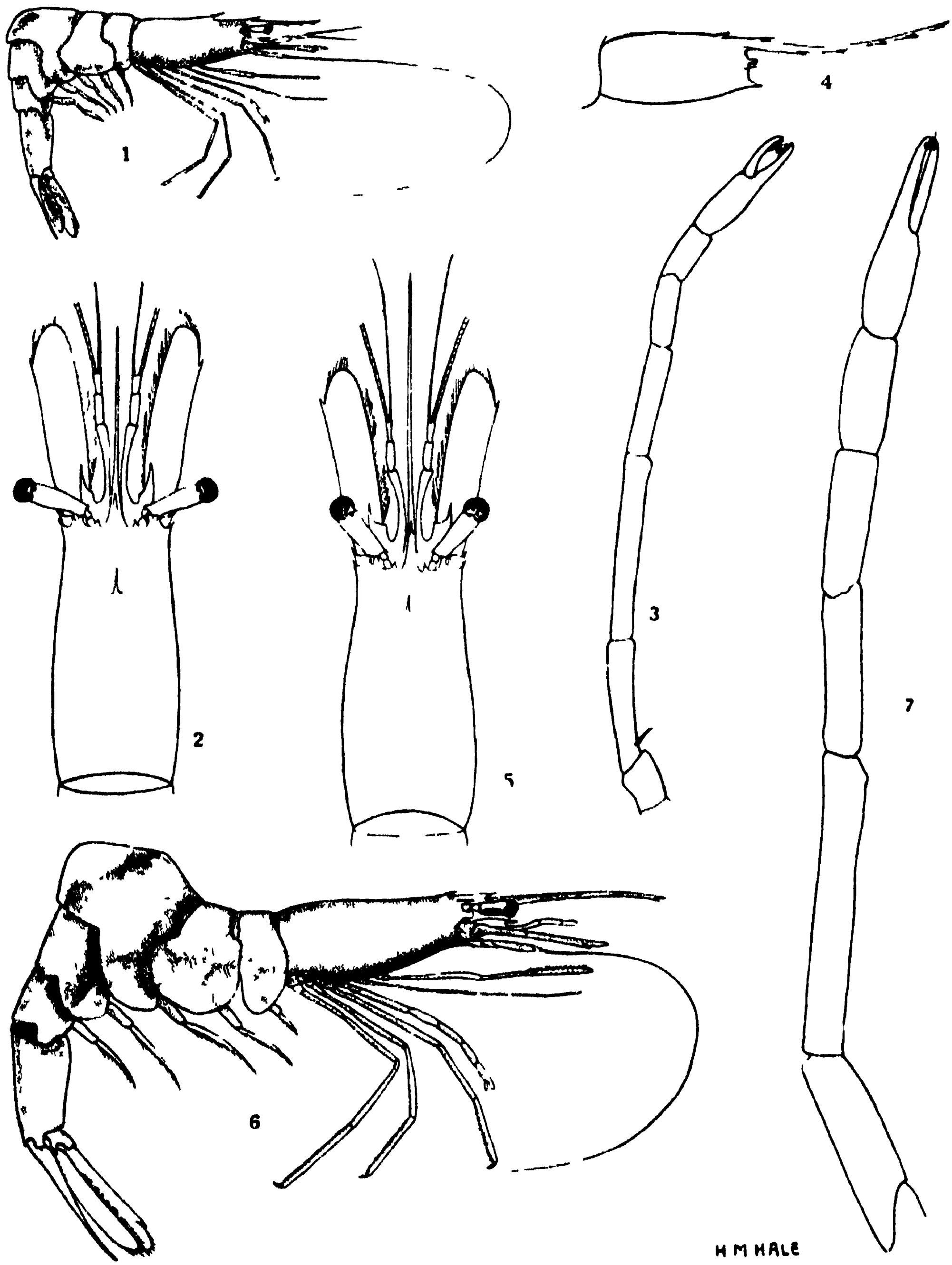

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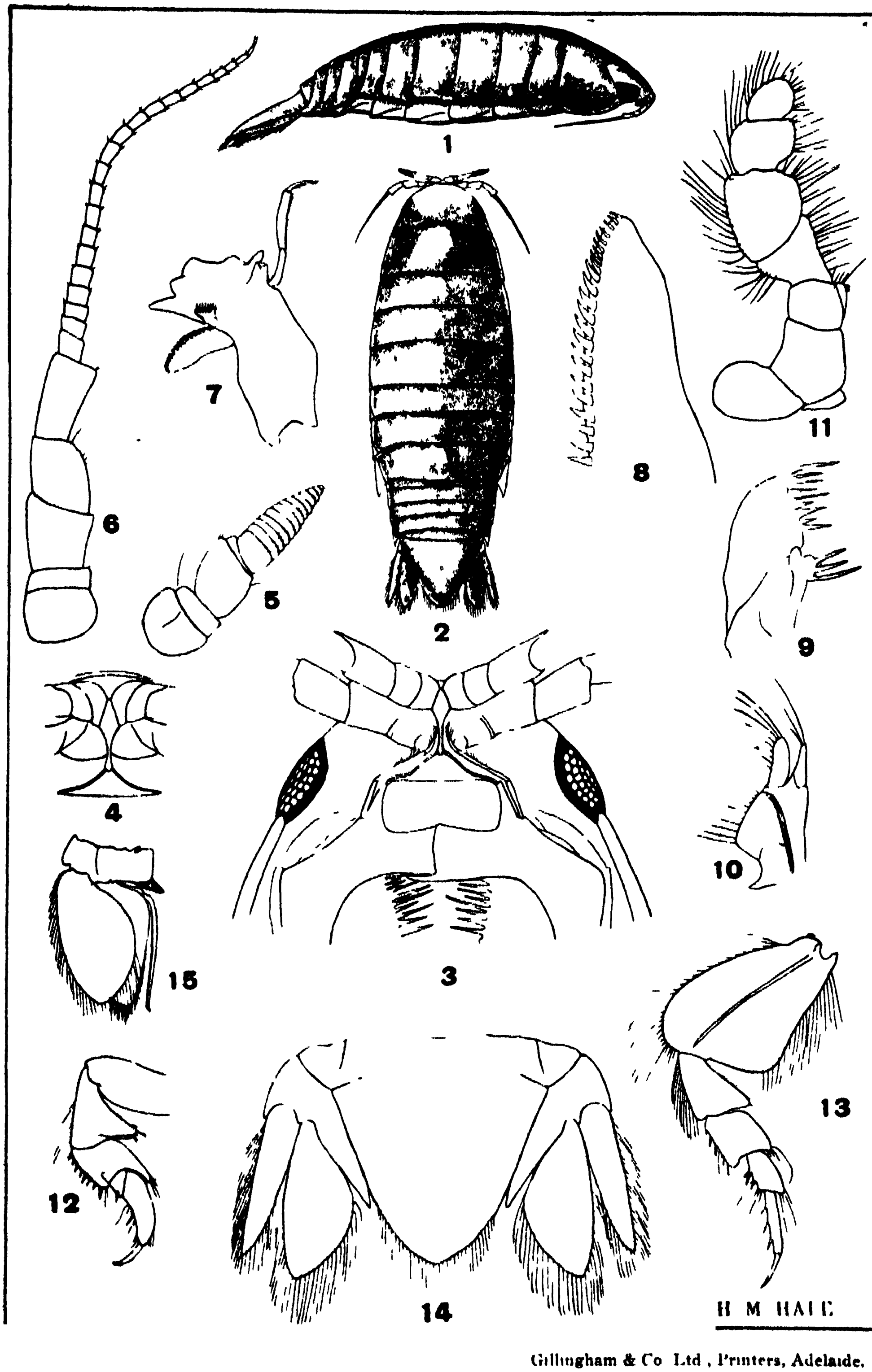

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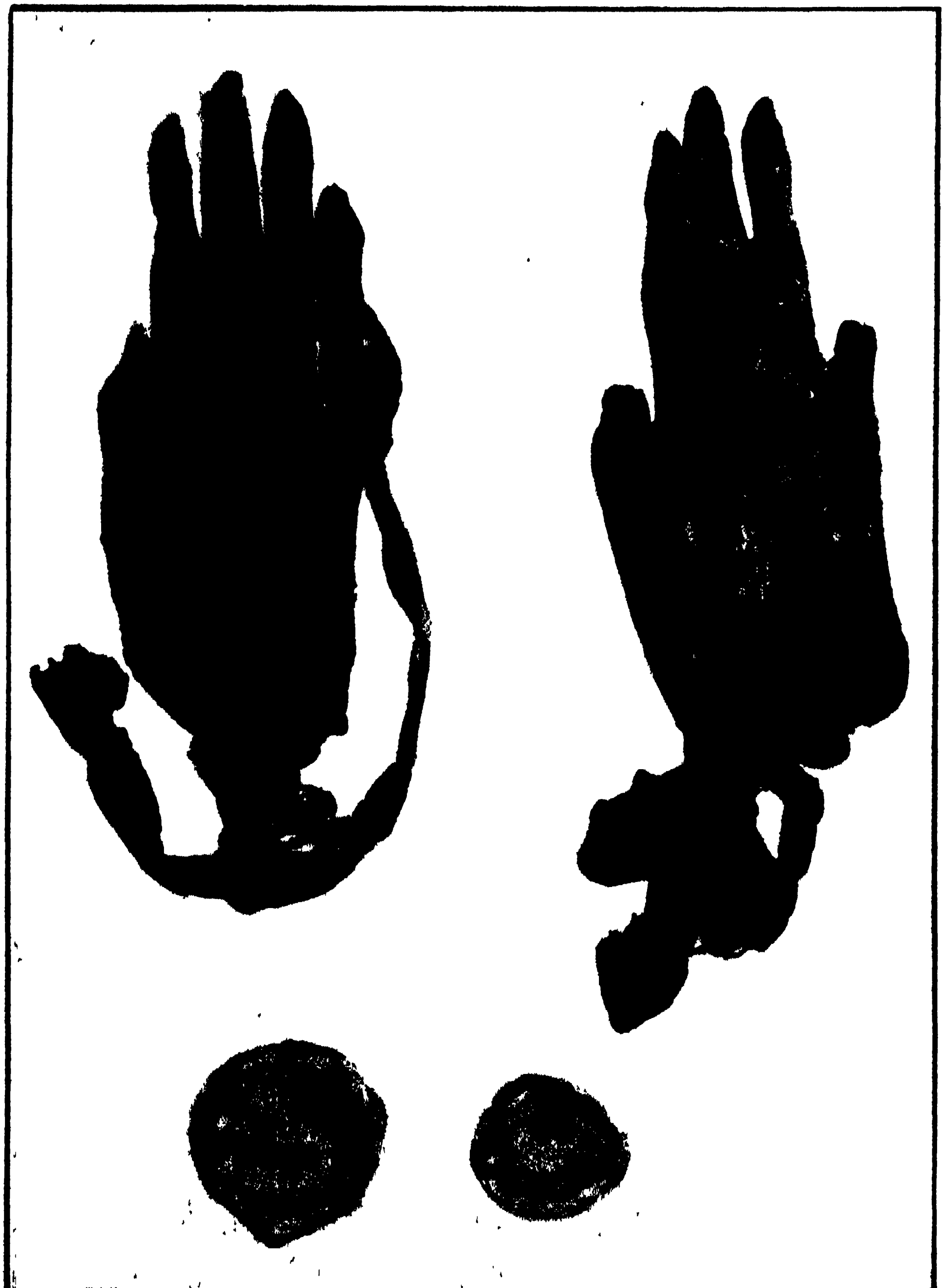

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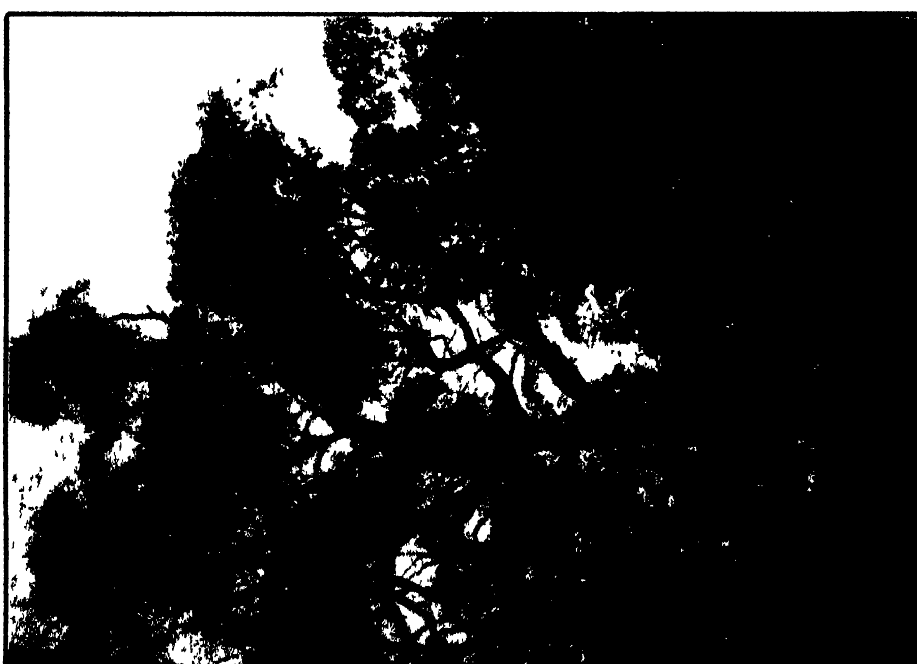

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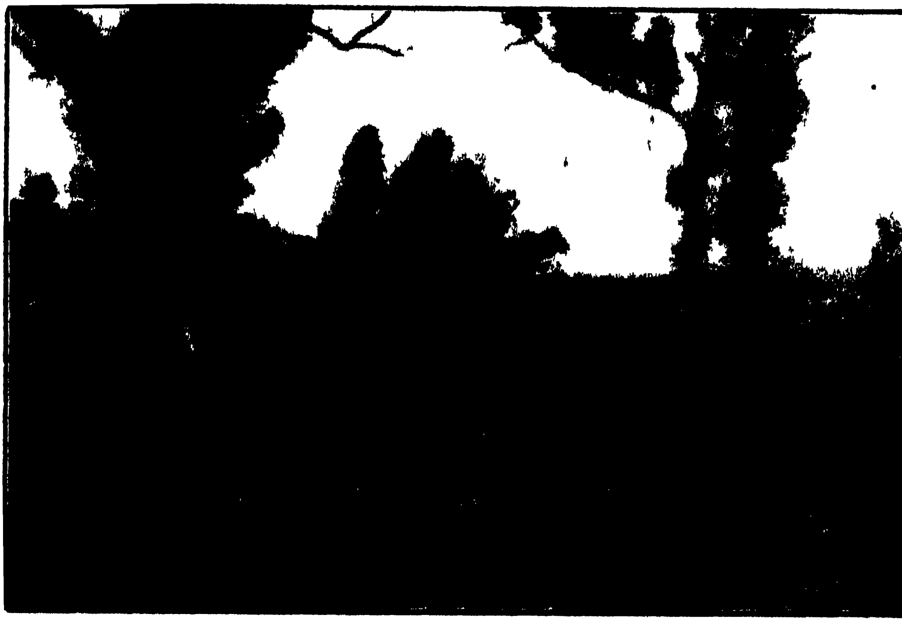

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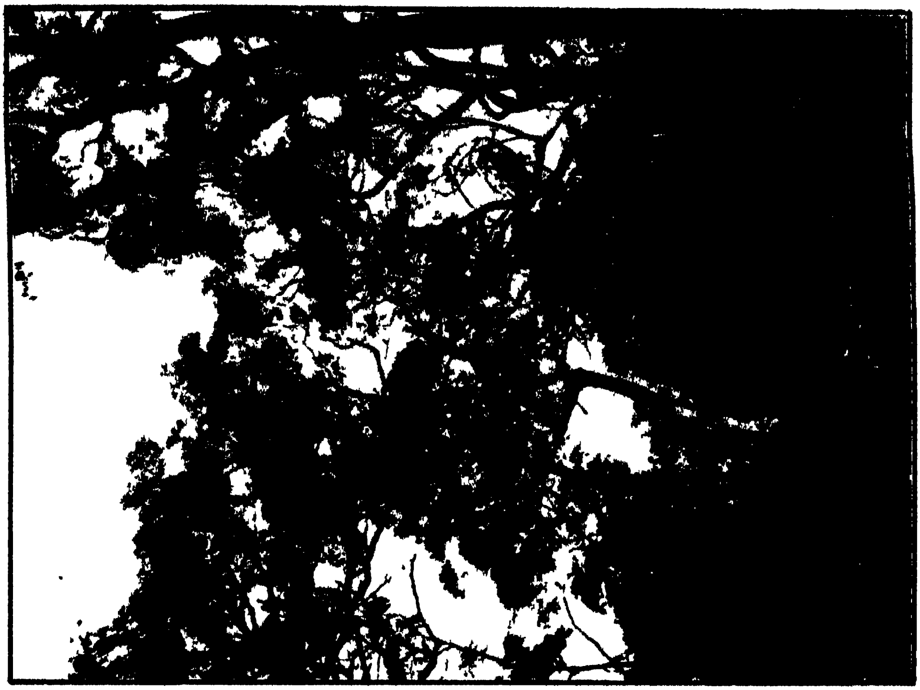

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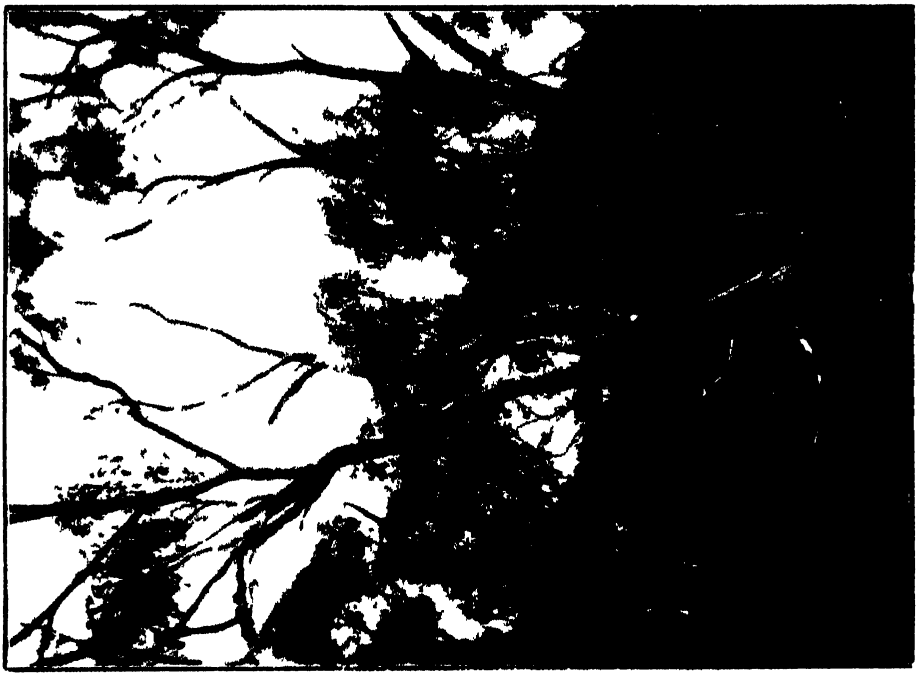

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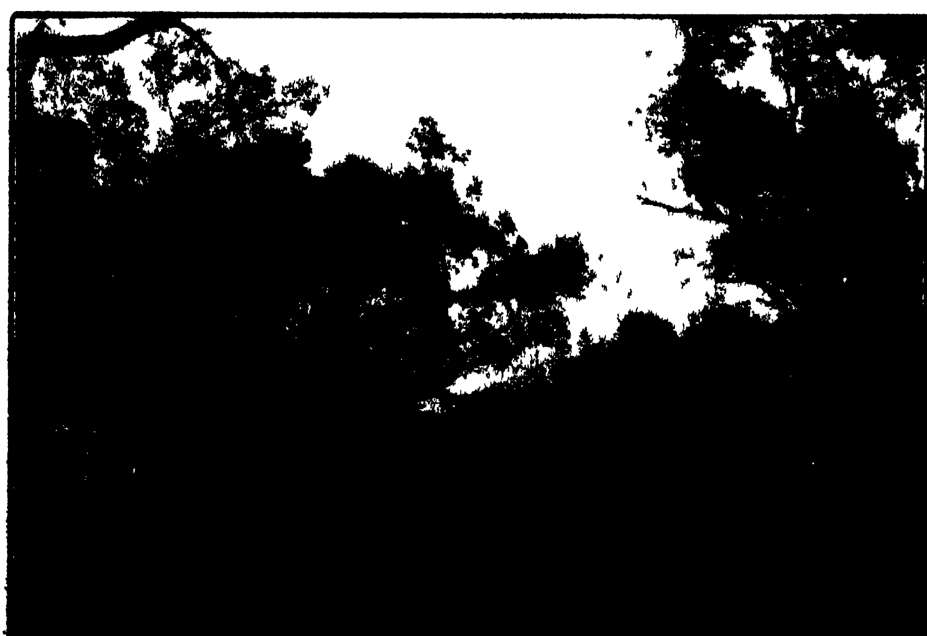

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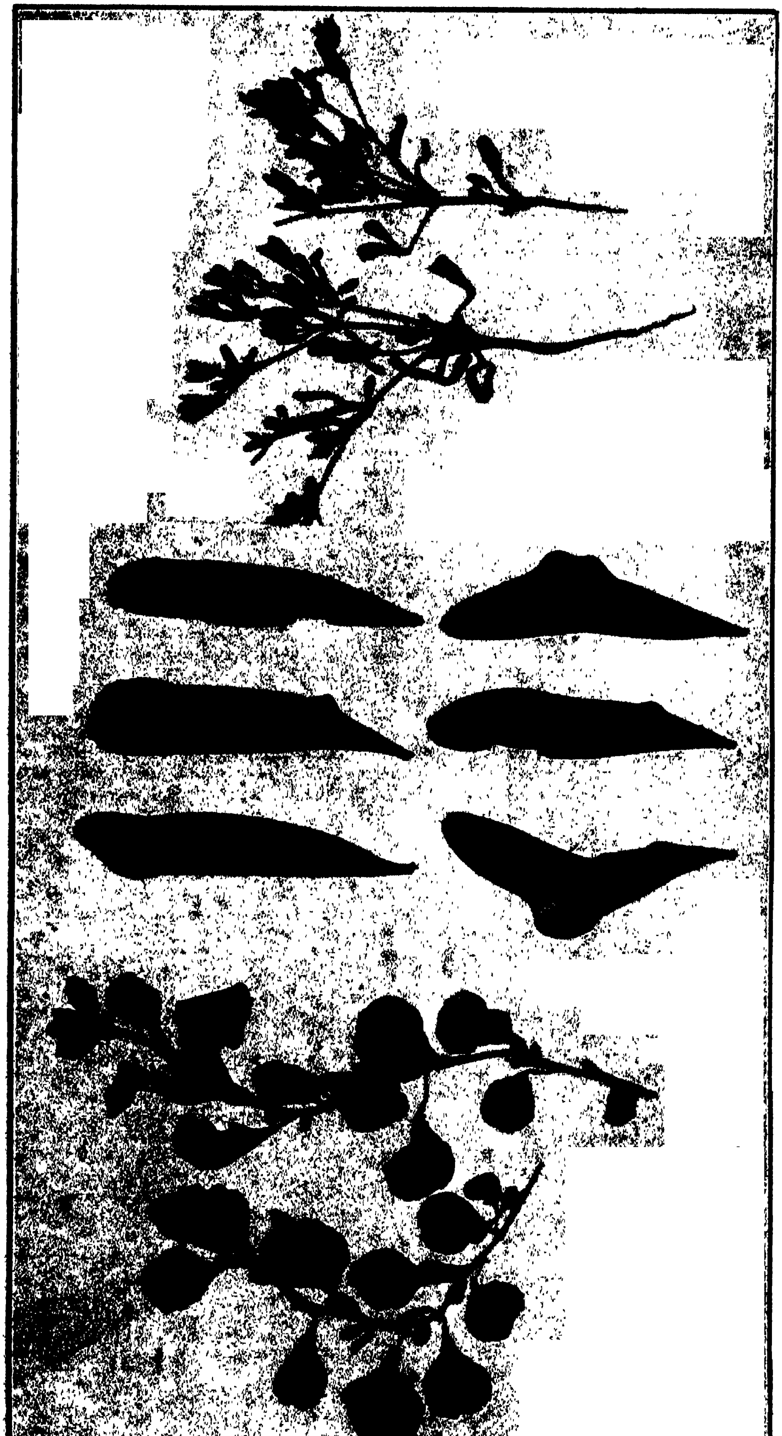

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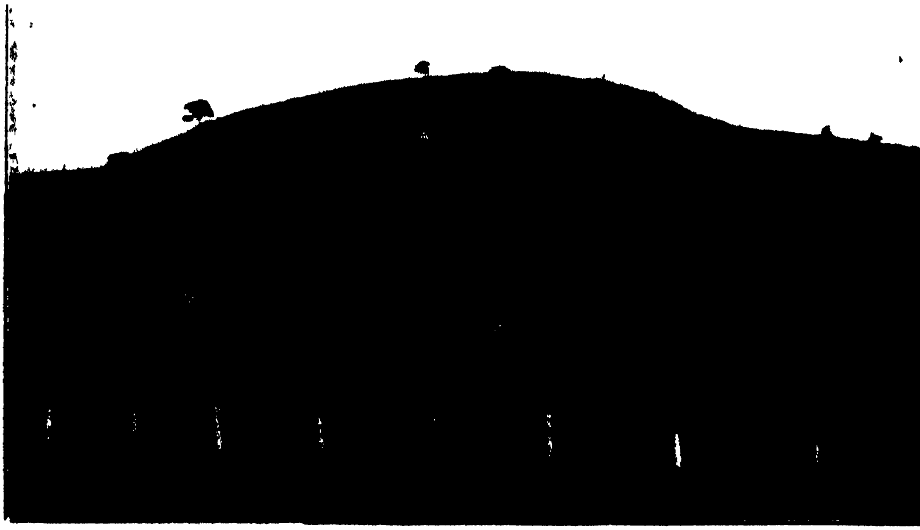

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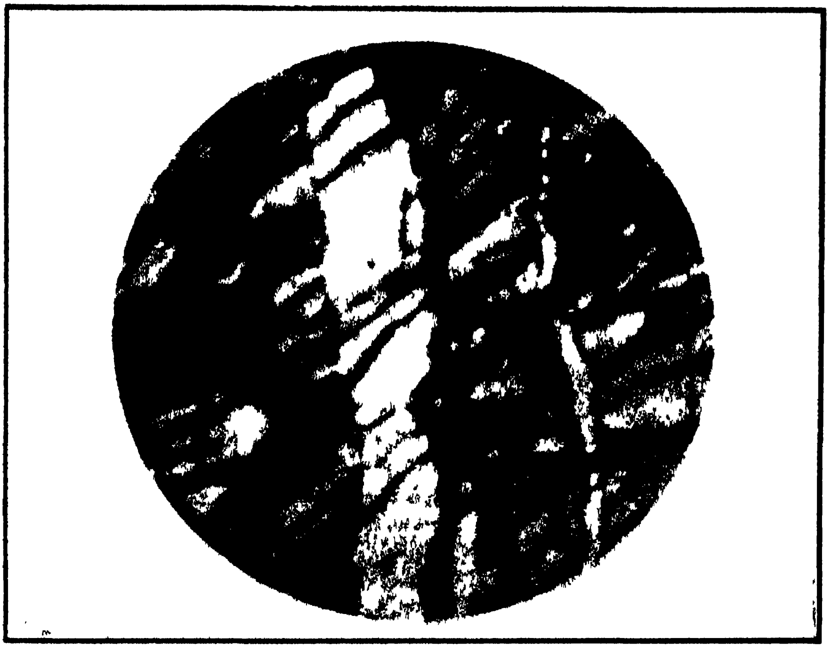

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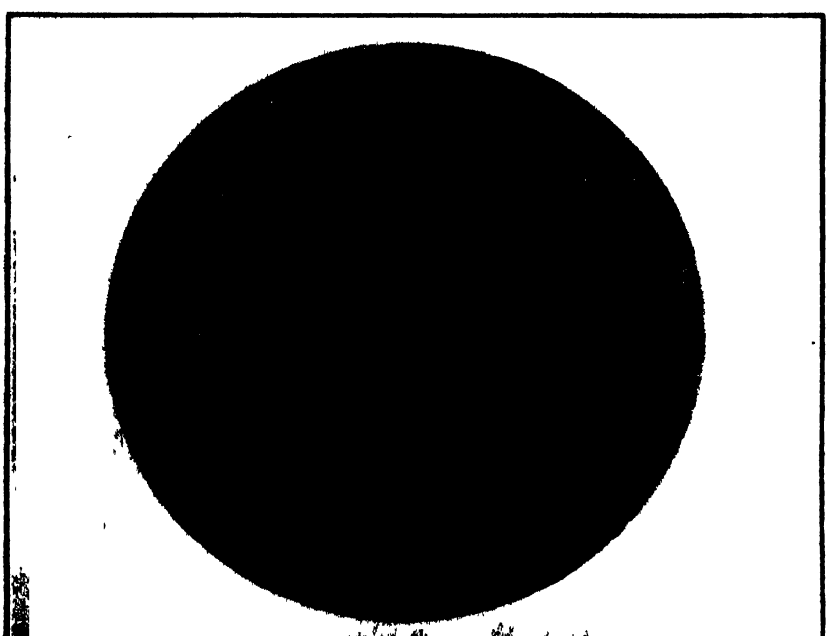

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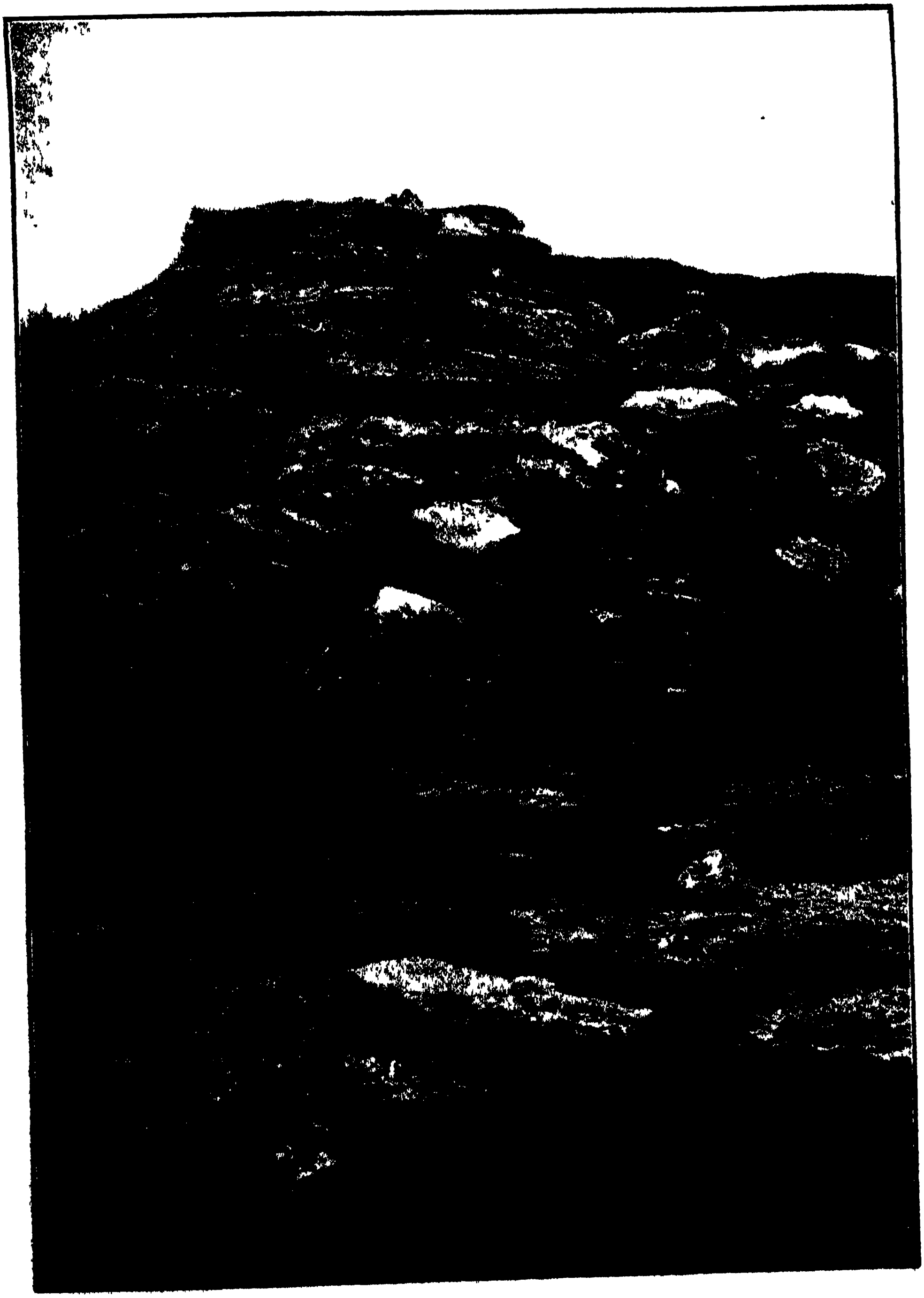

Upper part of Tillite capped by 3 feet of Fossiliferous Pliocene.

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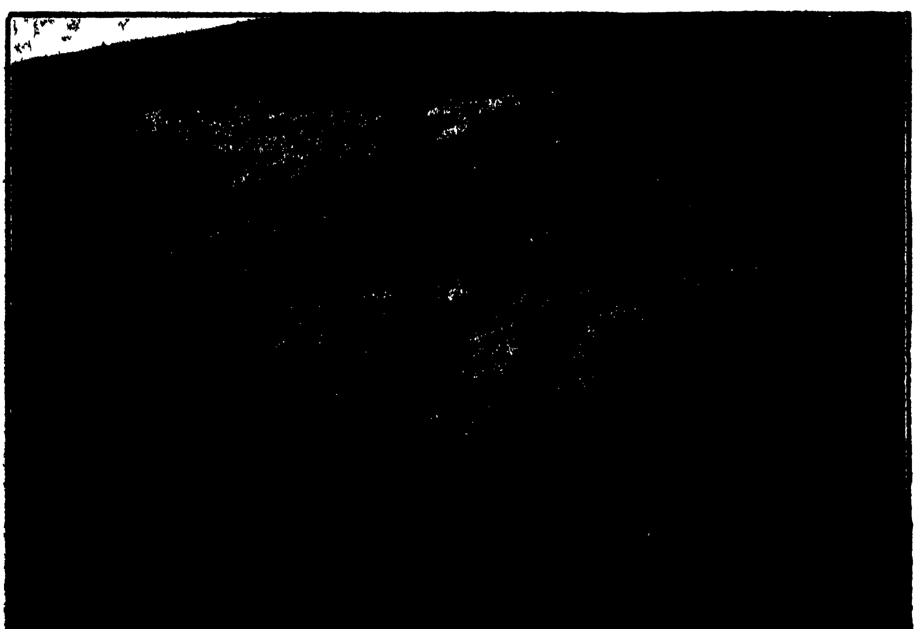
Fig 1



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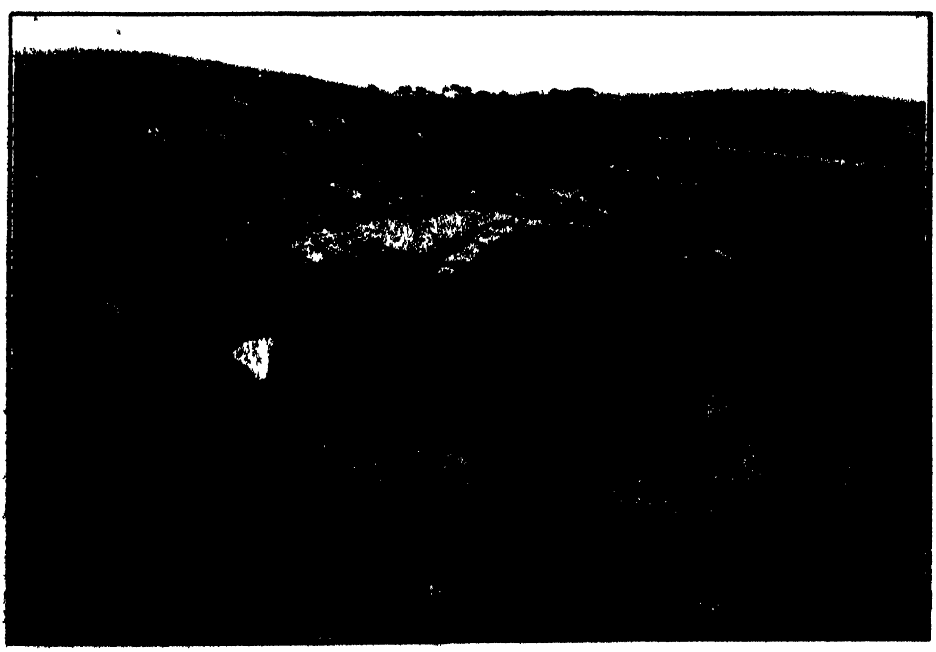

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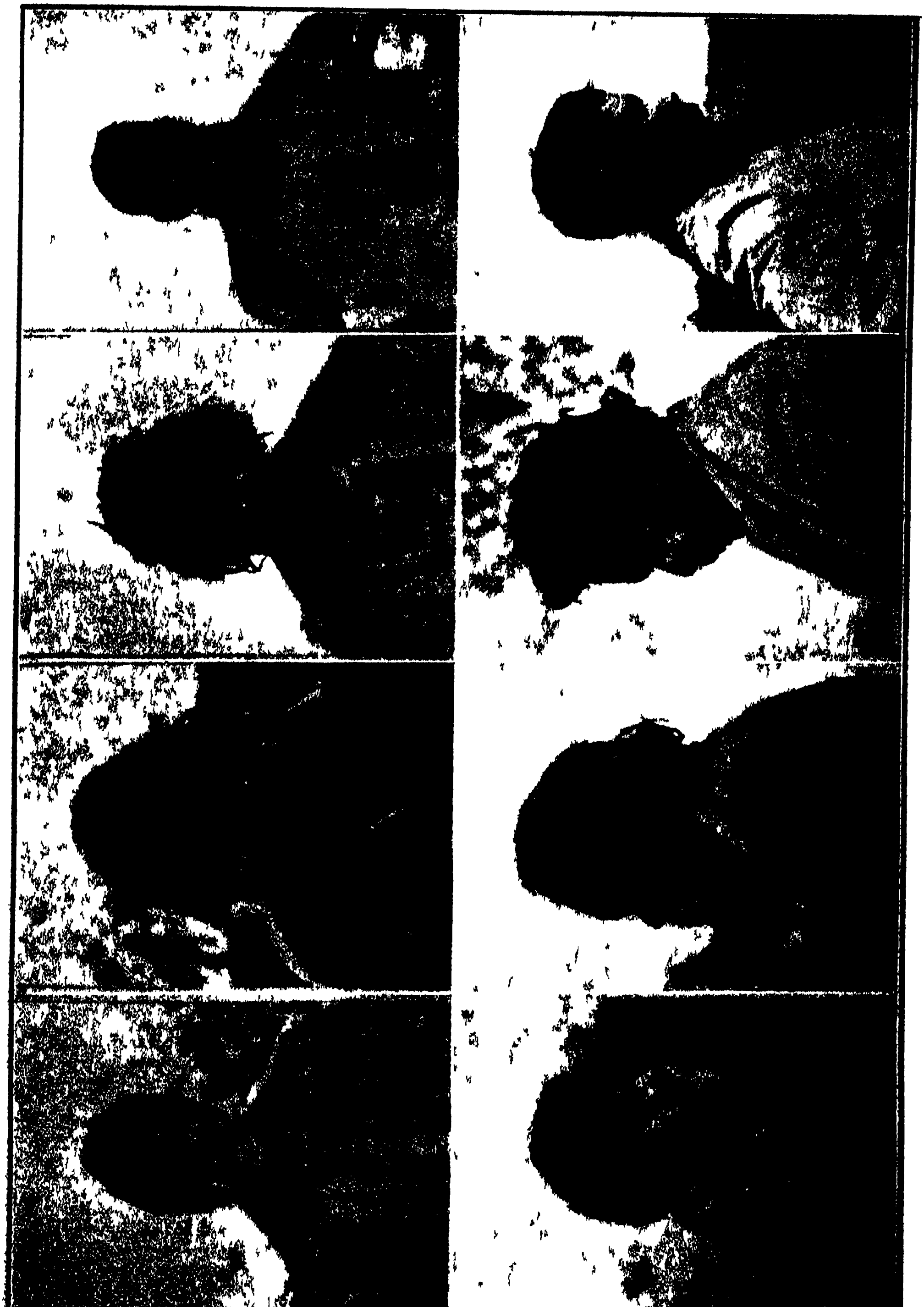

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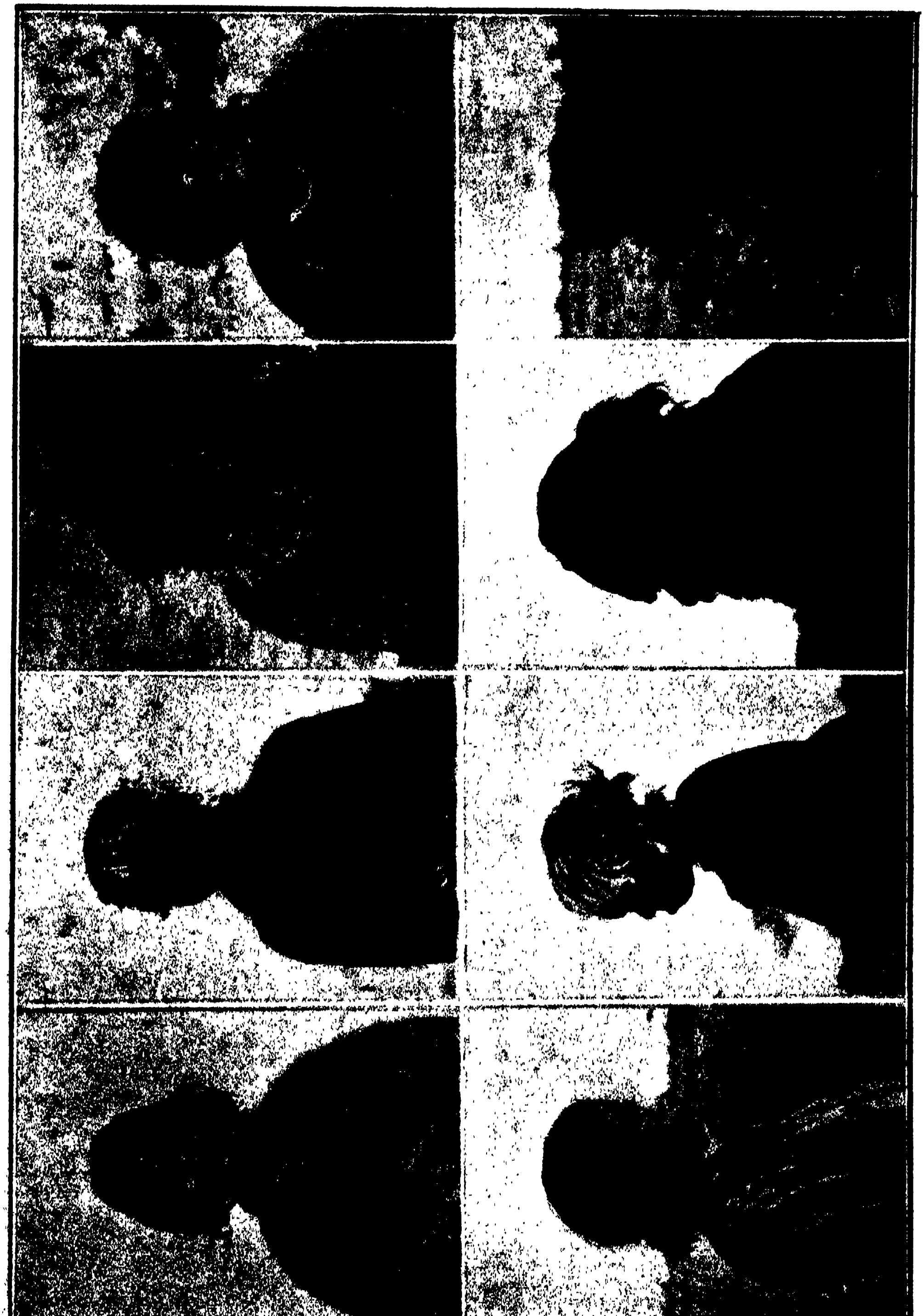

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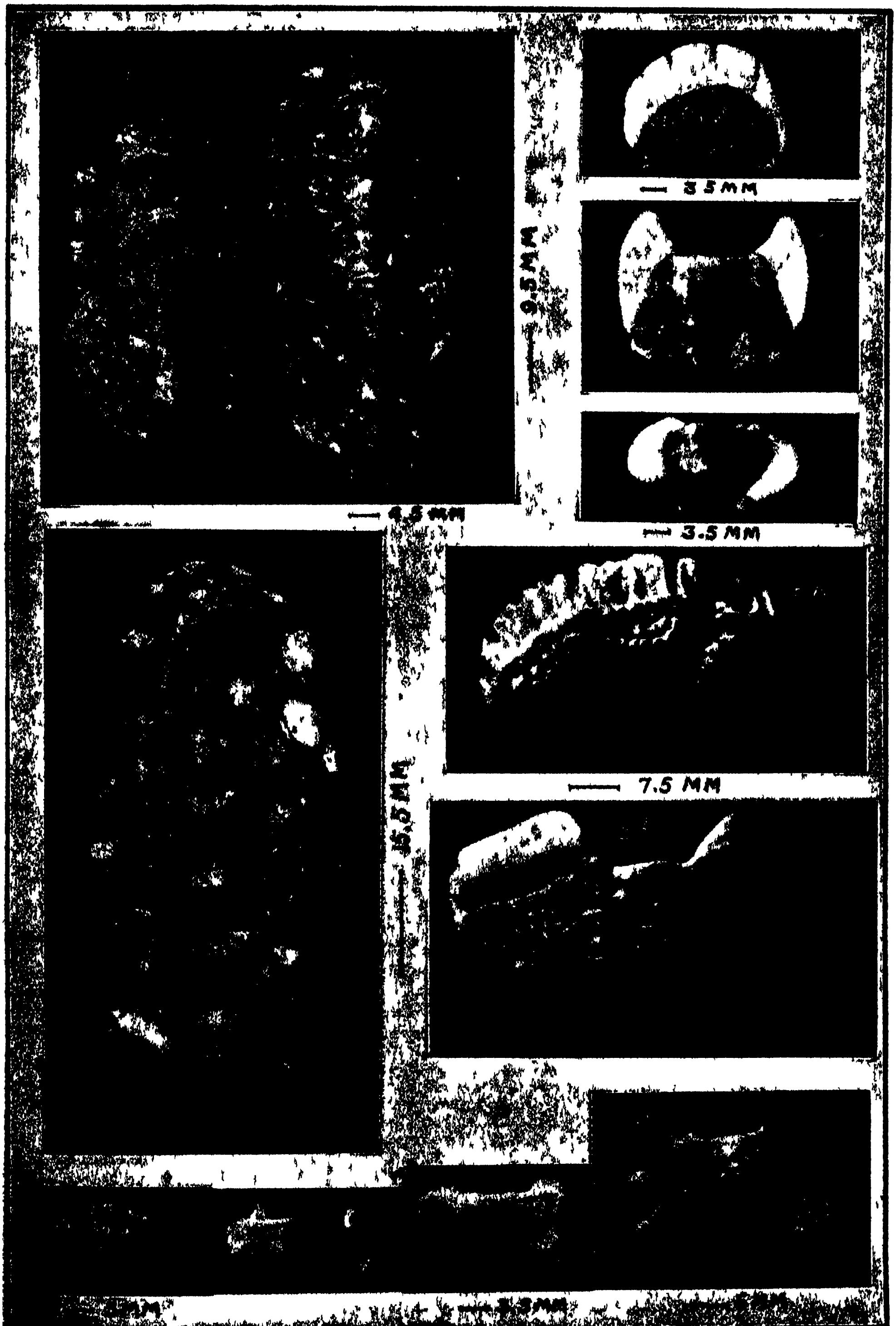

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